SURGERY

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A TEXTBOOK FOR STUDENTS

BY

CHARLES AUBREY PANNETT

B.Sc., M.D., F.R.C.S.

PROFESSOR OF SURGERY, UNIVERSITY OF LONDON
DIRECTOR OF THE SURGICAL UNIT, ST. MARY'S HOSPITAL, LONDON
SOMETIME MEMBER OF THE COURT OF EXAMINERS R.C.S. ENG., AND EXAMINER
TO THE UNIVERSITIES OF LONDON, MANCHESTER AND CARDIFF

"And he said unto me, Son of man, can these bones live? And I answered, O Lord God, thou knowest."

Ezekiel xxxvii. 3

He knoweth nothing as he ought to know, who thinks he knoweth anything without seeing its place and the manner how it relateth to God, angels and men, and to all the creatures in earth, heaven and hell, time and eternity.

Thomas Traherne

SECOND EDITION

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PREFACE TO SECOND EDITION

Changes in current surgical practice have made the issue of a new edition necessary. The book has been completely revised. Some new matter has been added and some subjects no longer of importance omitted, so that it is very little larger than before.

At Dr. Courtney Gage's suggestion the representation of X-ray appearances have been changed into negatives. They still remain diagrams, and in such form, I believe, more helpful to the student than reproductions of the actual skiagrams from which they were made.

I have redrawn a number of the original illustrations and added a few new ones.

It is hoped that the character of the book has been preserved and that it will prove a greater aid to all those studying that complicated, and unfortunately often vague subject of general Surgery.

C. A. P.

April 1947

PREFACE TO FIRST EDITION

The object of this book is to present the facts of general surgery in as few words as possible. There are so many good text-books of surgery that the issue of another can only be defended if it has qualities of its own tending to ease the already heavy burden of the undergraduate student. The subdivision of surgery, and the devotion of individual surgeons to one particular branch, has led to the multiplication of specialists. And they, although the scope of their own particular branch is often small, have persuaded the general surgeon that to practise it is quite beyond his capacity. In many cases the specialist's facility in technique can only be acquired by the constant practice obtained by confining his work within these narrow limits. But the facts of the speciality and the principles on which he works are within the compass of the general surgeon's wit. Very often, indeed, the latter is skilled in one or other of these particular branches. However that may be, there does not seem to be any strong case for multiple author text-books for the undergraduate student. In them there is usually overlapping, and always some unevenness in the standard of writing, and in the presentation of the subjects. Moreover, at his pass examination it does not seem fair to expect the student to have more exact knowledge than his examiner possesses, or to have read a series of monographs by experts. Hence in this book the assistance of no other author has been invoked. The surgery of the eye, the nose, ear and throat are without the province of the general surgeon. In these branches craftsmanship completely different from that of general surgery is in use. They have therefore been omitted. Gynaecology, whilst it is carried out by the same instruments and on the same principles as general surgery, has, for the student, a separate examination of its own and so finds no place.

The fundamentals of pathology and bacteriology are taught by pathologists and must be read in text-books devoted to this science. The student will not need them in his text-book of surgery, which by their omission is lessened in bulk. The details of operations have been deliberately left out. Then again the many paragraphs on differential diagnosis are largely redundant, as the important points

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should be brought out in the description of the clinical features of the disease. This plan, it is hoped, makes the book easier to read, and, being shorter, the task of reading it lighter.

The pictures are intended to illustrate definite facts and to drive them home. In general they are not representations of actual appearances; they are largely portraits of mental conceptions; of what the surgeon believes to be the pathological process within the confines of the body; of the altered dispositions of diseased viscera. The difficulty of communicating such mind-pictures to an artist is so great that it was felt it would be better to have these ideas depicted more exactly with an imperfect technique than erroneously by a skilled craftsman. It is hoped that the reader will perceive thereby some compensation for their obvious shortcomings in artistic feeling and execution. The skiagrams which form the basis of some of the drawings were all lent by Drs. Courtney Gage and Rohan Williams from the radiological department of St. Mary's Hospital; and pathological specimens from the museum of the same institution were selected for drawing by Professor W. D. Newcomb. To these three scientists I accord my most grateful thanks.

The book is based very largely upon a personal experience of many years as a general surgeon. I have only with reluctance and for the sake of completeness at times transgressed these boundaries. Shortcomings and omissions in text and illustrations are doubtless more numerous than I suspect. They are certainly greater than they would have been but for the war, which has exiled me to a part of the country far from libraries of reference, the opportunities for visiting which have been few. Nevertheless I believe that if the undergraduate student reads this book he will get a sufficient grasp of the subject to satisfy any examiner. He will, I hope, get his relative values right; he will not have burdened his mind with unessential operative technicalities; he will have an understanding of the main facts. The sanity of outlook induced will, I trust, leave his mind untrammelled by the belief in examiners' fads. Let him present himself confident that these individuals, the custodians of the public welfare as well as the arbiters of his knowledge, wish him well, and have but one single aim: to assess to the full his knowledge, and to help him through the ordeal of his examination. May fortune smile on him.

C. A. P.

January 1944

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CHAPTER I

TISSUE REPAIR AND THE TREATMENT OF WOUNDS

A KNOWLEDGE of physiology is essential for the practice of surgery. A surgeon must be familiar with the circumstances of the clotting of blood, with the reaction of the whole body to injury, with the facts of secretion and excretion, of immunology and many other things. He must know to what strain he can safely subject the heart and other vital organs and how far he can call upon their reserve function, but above all he must be acquainted with those dominant factors, inflammation and repair, which so largely determine the scope of surgical operations, for he cannot sever a single tissue of the body without these two phenomena coming into play.

When the tissues are divided blood and lymph exude from the cut surface of the wound. If the two surfaces are brought into apposition they become glued together by clotting of the blood and lymph. This is the first stage in tissue repair. Along the exquisite tracery of fibrin fibrils in the clot, wandering cells migrate. They come partly from the blood-stream by diapedesis, but the histiocytes also behave in the same way. All these cells are at first engaged in removing any damaged tissue or foreign matter which contaminates the wound. At the same time, into this scaffolding clot new vessels penetrate. They are capillary loops which bud out from the capillaries of the neighbouring living tissues. This collection of cells and capillary loops is granulation tissue, the primary repair tissue. As the process goes on the histiocytes become elongated to form fibroblasts and secrete white fibres so that the junction of the two surfaces is brought about by white connective tissue, the scar. Granulation tissue is red and vascular in appearance, but scar tissue gradually changes from red to white in colour, because the contracting white fibres obliterate the new-formed vessels. There are no elastic fibres in scar tissue, although elastic fibres do penetrate into the edges of a scar after some considerable period. The surface of the wound is covered by epithelium which grows in from the sides.

Scars formed on the surface of the body are at first a red colour and then become pale. They do not contain sweat glands, hair follicles or sebaceous glands. They have only a few elastic fibres and they are for long devoid of nerves.

Muscles, when divided, repair after the same fashion by fibrous tissue alone. There is very slight regeneration of skeletal muscle tissue itself. There is no regeneration of smooth muscle. Indeed, *very few specialised tissues of the body can reproduce themselves.* The spleen has this power to some extent, and so have the liver and the mucosa of the stomach. Bones, too, reproduce their own structure, but bone is only a specialised form of connective tissue and it is not surprising that the scarred bone takes on the form of the parent tissue.

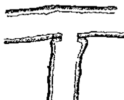
In order to make different parts of the alimentary canal adhere to one another it is essential that the epithelium covering the mucous membrane should not be interposed between the two surfaces. As the mucous membrane has a great tendency to pout between the edges of a wound in the stomach or intestine, the rule in suturing these viscera is that the margins must be turned in (Lembert's suture), or, more precisely, endothelial surfaces must be in contact.



Lembert suture.



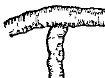
Lateral anastomosis.



Termino-lateral anastomosis.



Axial anastomosis.



Termino lateral anastomosis.



Lateral anastomosis

Suturing the Alimentary Canal

Tendons heal very slowly because they are so avascular. It has been found by experimental methods, that, in the first instance, union between the two ends of a tendon is brought about by the

ingrowth of granulation tissue from the surrounding sheath. It is only later that granulations form at the ends of the divided tendon itself.

Nerve cells do not regenerate at all and nerve fibres only when they have a neurilemmal sheath. Therefore, there is no regeneration of any nerve fibres in the spinal cord or in the brain. In fact, it may be said in general that divided tissues of the body are only joined together by fibrous tissue; hence the properties of scar tissue are a very important consideration in any surgical operation.

Scar tissue tends to contract as time goes on; so that if there is very considerable scar formation, deformities may be produced; as, for example, when burns occur on the flexor surfaces of the joints of the limbs. Contractures result unless great care is taken in the after-treatment; but although scar tissue contracts in this way, it is not very resistant to continued strain, before which it is liable to stretch. A wide scar of the abdominal wall may bulge and give rise to a hernia. A very important aim in surgery, therefore, is to reduce the formation of scar tissue to a minimum.

The factors which increase the formation of scar tissue are infection in the wound, the wide separation of the sides of the wound, necrosis of tissue and haemorrhage. If a wound surface is damaged, so that the superficial layers of tissue die, these must be removed before repair can take place. As they are removed they are replaced by granulation tissue. In this way a thick layer of granulation tissue is apt to form and give rise to much scarring. If the sides of a wound are brought into close apposition and healing takes place with the very slightest formation of granulation tissue, then this is called healing by first intention. Healing by second intention takes place when the wound surface is damaged chemically, by heat or by infection, so that healing only takes place with the formation of much granulation tissue. Sometimes the expression, healing by third intention, is used. This name can be given to the healing which takes place when two granulating surfaces are brought together by sutures and induced to unite.

Infection is the biggest factor which interferes with the healing of wounds. The number of species of bacteria which are pathogenic and are actually found in wounds is surprisingly small. The *Staphylococcus aureus* or *albus* is found in two-thirds of all infected wounds. The streptococcus is found in about 10 per cent of them. The staphylococcus is apt to give rise to an inflammation associated with the formation of thick white pus, whereas the streptococcus causes an infection accompanied by the exudation of a thinner sero-purulent fluid containing fewer leucocytes. The *Bacillus coli* and the *Bacillus*

proteus are found in wounds, not usually alone but in association with staphylococci and streptococci. They are inhabitants of the alimentary canal and so they are seen particularly in wounds which are infected from this channel; in appendicitis, for instance. The *Bacillus pyocyaneus* is occasionally seen and gives rise to the greenish-blue pus, so characteristic; only very seldom is it found alone. It is usually regarded as a mild infection but when alone it may be very serious. Diphtheroid bacilli or true diphtheria bacilli are sometimes seen in wounds, and also the *Bacillus subtilis*, a non-pathogenic organism, as a rule, but one which apparently assists other organisms to grow. The very serious gas infections are produced by the *Clostridium Welchii*, *septicum*, or *Oedematis maligni*.

Treatment of Wounds

Since microbes interfere so much with the healing of wounds, the prevention of their access is of primary importance. It goes without saying that all instruments and materials which come into contact with an operation wound must be efficiently sterilised. Boiling water for ten minutes will kill all the ordinary pathogenic organisms. If sodium carbonate be added to the extent of 1 per cent, the boiling point is slightly raised and steel instruments are protected from rusting. Soda should not be used when sterilising rubber, silkworm gut, linen thread or silk. The autoclave of the bacteriological laboratory is used for the sterilisation of dressings. It is very important that the steam should be able to penetrate into the interior of the drums containing the dressings and into the interstices of the materials themselves. This can only be effected if there is an efficient mechanism for first producing a vacuum and withdrawing all the air before the admission of the steam. When this has been done, three-quarters of an hour at 18 or 20 lb. pressure is sufficient. In the middle of the drums, or anyhow in the midst of random specimens of the drums, should be placed some device for recording the temperature which has been reached during sterilisation. This may consist of a dye which changes colour or a metal which fuses.

Rubber gloves should be sterilised at a somewhat less pressure (10 lb. for 30 minutes) for a higher temperature is rather destructive to rubber. But the gloves should be placed in the autoclave with the fingers higher than the rest of the glove, so that heavy non-conducting air pockets may not be formed in the fingertips.

Scalpels or scalpel blades are sterilised by boiling by many surgeons, but others rely upon chemical sterilisation. An effective solution is:

Borax	. . .	1·5 gm.
Formalin	. . .	2·5 c.c.
Liquid phenol	. . .	0·4 c.c.
Distilled water	.	to 100 c.c.

The scalpel blades should be left in this solution for at least 24 hours. They do not rust if left in it for weeks.

Silk or silkworm gut and horsehair are three ligatures which are best sterilised in boiling water or, better, boiling in 1/1000 mercuric chloride solution, so that they become impregnated with this antiseptic. Cotton in sizes 30 and 60 may also be used, but as it is difficult to manipulate wet it is better autoclaved. Catgut is a very difficult substance to sterilise, and as it may have been contaminated with spore-forming bacilli, which are extremely resistant to antiseptics and heat, the difficulty is increased. It cannot be boiled in water because this hydrolyses the collagen of which it is composed into gelatin. However, reliable methods have been worked out and commercial catgut can usually be depended upon to be sterile. The sterilisation is effected either by immersion in tincture of iodine for a definite period or by the action of heat after all water has been extracted from the catgut.

Contamination of wounds with bacteria takes place mainly by contact (contact infection). It is particularly difficult to ensure that the skin, both of the patient and of the surgeon, is free from bacteria. It is never possible to be absolutely certain of this. In the case of the patient the area of the body which is to be subjected to an operation is washed with soap and water on the day before the operation, hardened by the application of alcohol, and covered with a dry sterile dressing. At the time of the operation the skin is usually painted with an antiseptic, of which the best is tincture of iodine. This procedure may sterilise the surface of the skin, but there are organisms lying deep in the sebaceous and sweat glands. As these glands are divided in the skin incision, such organisms may be set free. It is also possible that, during a long operation, these deep microbes may come to the surface. Therefore, to the skin edges are usually attached sterilised towels to avoid further contact of the skin with the hands of the surgeon or the instruments. The preparation of the surgeon's hands before operation is not so simple. It is impossible absolutely to sterilise the skin, as has been already pointed out, and, even were it possible to sterilise the surface before an operation, sweating of the hands during its performance might set free more organisms. No surgeon's hands would stand the repeated application of tincture of iodine. The most practical method of hand preparation has been

found to be a careful washing in soap and water, paying strict attention to the grooves beneath the nails which should be kept short, followed, after rinsing off all the soap, by an application of cetavlon. A surgeon should not engage in manual labour which makes his skin rough and therefore difficult to clean, nor in work which is liable to cause small abrasions which will also interfere with cleanliness. Above all, he should be careful to avoid contamination of his hands. That is, he should be very careful not to get them soiled with pus or pathological effusions. The organism which is normally on the hands is the *Staphylococcus albus*, an almost non-pathogenic microbe. The organisms which are most serious as contaminations are those which have already lived in the body and become adapted to this environment. That is why it is so important to avoid contamination with pus and pathological secretions. Experiment has shown that there is some natural mechanism which destroys microbes which may be deposited upon the hands. Thus, if a culture of the streptococcus be rubbed over the fingers, it is found that the number of organisms which can be recovered from a definite area of the hand diminishes rapidly as the hours pass. At the end of a day it is usually impossible to detect them at all. This natural mechanism would appear to be due to some antimicrobic action of skin secretions. It will be seen, therefore, that although careful washing of the hands before an operation is of great importance, it is of still more importance to prevent the hands from becoming contaminated. They should always be protected by rubber gloves, whenever they are likely to come into contact with pathological microbes. The gloves which are used for operations are sterilised in the autoclave. Gloves should be drawn on to the hands without their outer surfaec coming in contact with the skin of the hand. This can be done if the wrist of the glove before sterilisation is turned back as a cuff presenting the deep surface for grasping.

As well as this contact infection, the wound may be contaminated from the air. That microbes do float about in the atmosphere can be easily demonstrated by allowing agar plates to lie exposed in an operating theatre. A crop of non-pathogenic organisms will be obtained, but always some staphylococci and very often some streptococci. Air contamination is a greater danger in a hospital, where infective diseases are collected, than outside. If a drop of pus should fall on the floor and dry and become pulverised, a current of air may waft bacteria into the atmosphere and lead to air contamination. Therefore, it is extremely important not to let pathological secretions dry but to collect them all in dishes or other receptacles, smothering them with water if necessary. Microbes cannot escape from a

liquid. They only have a chance to disseminate when the liquid dries up. In considering air infection, it must be borne in mind that more than the area of the wound is concerned. Organisms may fall on to swabs or instruments, and by them be conveyed to the wound, in which case there is a combination of air and contact infection coming into play. The great sources of air infection are the throat, mouth and nasal cavity. During gentle breathing expired air which comes from the nose is sterile, but forcible expiration, or sneezing, talking or coughing, cause minute droplets, containing bacteria, to be discharged into the atmosphere. Many people's throats have non-haemolytic streptococci in them. Droplet infection becomes a very serious matter when participants in an operation are suffering from a cold, laryngitis or pharyngitis. It can be guarded against, to some extent, by wearing efficient masks. If an operator is healthy his nostrils may be free, which is a great comfort to him, but if he is suffering from a cold or has any sinus disease or pharyngitis, it is wiser to keep his nose covered. When removing the mask, care must be taken not to handle that part which traps the microbes, or a heavy implantation of bacteria on the fingers may take place.

Contaminated footwear is another source of air infection. This can be guarded against by the provision of coverings for the feet which, in some cases, can be sterilised, but in any case are never allowed outside the operating theatre.

The use of aerosols before operating is a possible way of clearing the air of many bacteria. Some surgeons work under an ultraviolet light beam. Ultraviolet light is certainly an effective sterilising agent but it is questionable whether its general use for this purpose is desirable.

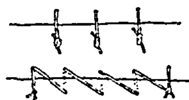
Ligature material is important from the point of view of infection. In a wound which is already contaminated, silk, as a suture material, should not be used. It is not absorbed and may remain as a permanent source of irritation and sinus-formation. The interstices in silk are of so minute a size that within them microbes can find refuge in spaces which are too small for the entry of phagocytes. Here they can grow unchecked. Catgut, because it is eventually absorbed, is free from this disadvantage. In an aseptic wound, however, catgut appears to produce more irritation and more reaction of the tissues than does silk, so that when nerves or tendons are joined together, silk is the preferable material. As a suture material silk is returning to favour for any operation in which the tissues are not infected. Indeed there is a growing feeling that thin silk or cotton has no disadvantages compared with catgut even in a septic wound. For it is pointed out that, in the presence of sepsis, the absorption of catgut is interfered

with, so that catgut ligatures are frequently extruded before healing can take place. Moreover, the protein of the catgut provides pabulum for the infecting organisms.

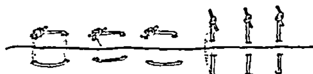
It must be clearly understood that the sutures used in surgery perform a very different function from those employed in the making of clothes. The seams of a coat are held together by the stitches, and on the closeness of these the strength of the join depends. In a wound the stitches are only used as a splint to keep the edges together until the natural process of repair takes place. The strength of the junction depends upon the perfection of the vital healing process. The fewer sutures inserted the better. The tissue within the grasp of a suture inevitably suffers from pressure necrosis, so that if the stitch be pulled tightly the whole of the tissue within its grasp will die and the stitch will cut out. It is a fallacy to expect that a wound will be permanently stronger if non-absorbable sutures are used. The pressure necrosis which takes place makes any suture loose and ineffective as a binding agent after an interval of time, which is possibly two weeks or more. Therefore, the rule in surgery should be to place as few sutures as possible in a wound and to avoid tying them too tightly; simple apposition of the opposing surfaces is all that is necessary. On the other hand, certain other considerations sometimes come into play. For instance, the suture of one part of the alimentary canal to another must be made water-tight and this necessitates one row of sutures at least being placed closely together. Or again, the peritoneum after a laparotomy must be brought together without the spaces between the stitches being too long or the omentum will insinuate itself between the stitches and a hernia result. Simple interrupted sutures which run transversely across the wound edges cause less interference with the circulation than mattress sutures.

From what has been said of the process of repair in wounds, it is obvious that the closer the apposition of the wound surfaces the easier it is for repair to take place and the less the resulting scar tissue. Anything interposed between the living cells whose activity brings about the junction delays repair. Hence, it is important to stop all haemorrhage. A blood clot in the wound not only separates the surfaces but forms a very favourable medium for the growth of bacteria. Vessels of any size must be ligated but, here again, some sense of values is necessary. A small vessel which will quickly stop bleeding and perhaps be induced to do so by pressure for a few minutes, is obviously better left untied, because the ligature itself inhibits repair in its neighbourhood and the part of the vessel distal to it dies and has to be removed. It can also be seen how essential it is to avoid injuring the tissues by clumsy operating. A delicate

technique, clean cutting with a knife, avoidance of tearing of the tissues and damaging them by pressure all assist in the healing of the wound. Delicate tissue cells which have been hurt by operative injury are in no condition to initiate repair. Tissue that dies must be removed by the phagocytes before healing can take place. From this point of view the use of the diathermy cautery as a haemostatic agent is not very desirable, particularly as the depth to which the heat penetrates is not very certainly known. Another important condition for easy repair is the fixation of the wound. The first bond between the incised surfaces is excessively fragile and any unnecessary movement is liable to damage it. For this immobilisation of a wound it is very often desirable to apply splints. In the case of the trunk,



Interrupted and continuous sutures.



Mattress sutures. Those perpendicular to the line of incision cause less disturbance of the blood-supply to the edge of the wound.

particularly the abdomen, there is a reflex inhibition of the muscles which subserves the same purpose.

After a wound has been sutured it needs protection from external contamination. The best dressing is sterilised gauze covered by a layer of sterilised wool. Of course, it is essential that there should be a good blood-supply to a healing wound, nutritive material must have easy access, and the products of digestion of injured cells must have free means of escape, so that it is obvious that the general condition of the patient must have an influence on wound healing, whilst the circulation in the neighbourhood must be good. In the case of the limbs elevation often helps the absorption of inflammatory products and so opens the way for new material to reach the part.

A deficiency of Vitamin C prevents the formation of collagen fibres and so may lead to the dehiscence of wounds when sutures are removed. Hence, in wasted patients, particularly those suffering from malignant disease, ascorbic acid should be given both before and after operation. The dose should be 500 mg. on the first day,

followed by a daily dose of 100 mg. As a deficiency in serum proteins also militates against wound healing, a diet rich in protein is indicated.

The stimulus which sets repair going is not very clear. It is known that there are chemical substances in embryonic tissue which are a great stimulus to the division of cells. It is supposed that the products of cell disintegration initiate the changes which lead to repair, but what these substances are exactly is quite unknown, and it is not very profitable to speculate in this connection, though their discovery and use for the artificial stimulation of repairing wounds opens up a vista of wounds healing in a day or two instead of in weeks.

Antiseptics

It has been pointed out that every operation wound has bacteria introduced into it, partly from the air, partly by contact. If the implantation is small the defensive properties of the plasma, the leucocyte and the fixed tissue cells are able to deal with them and there is no disturbance of the processes of repair. The question, however, arises whether the organisms which thus gain access to the wound could not be killed by the application of a chemical antiseptic. It may be said at once that any such escape from this difficulty is at present nothing but a dream. There are many excellent killers of bacteria in the laboratory, but almost without exception they either lose their efficacy when mixed with serum, are too poisonous, or damage the leucocytes and tissue cells as well as the microbes. When used in a wound they leave behind them a thin layer of necrotic tissue which must be removed before true repair can begin.

There is one exception, penicillin, which seems to be quite harmless to tissue cells, but even this agent cannot be relied upon to exterminate a heavy surface infection, and it is only active against certain organisms.

Phenol (1 in 20 to 1 in 60) is a useful solution in which to keep glassware, catheters, silk or other objects which have been boiled. *Mercuric biniodide* (1 in 1000 to 1 in 6000) is used for similar purposes. *Formalin* (40 per cent formaldehyde) is used as vapour for sterilising gum-elastic catheters, particularly ureteric catheters.

Dettol, a coal-tar derivative, is not very harmful to tissues; it does not coagulate proteins and acts quickly. Washing out a wound for 10 minutes with a 5 per cent solution will kill many of the bacteria and do little damage to the tissues. Indeed, it is not necessary to kill all the microbes in a wound, for there is a minimal infecting dose. Below this the organism can deal with the bacteria.

Proflavine (1 in 1000) in buffered isotonic solution (Isoflave) is sometimes used for irrigating foul wounds. Its action is but little impaired by the presence of protein and it does not do much harm to cells. Clinically its effect is not very striking. It acts so slowly.

Sodium hypochlorite is an antiseptic which has also been much used where, as in an empyema, there is a fibrinous exudation to be dissolved. It is best used as Milton (1 in 5).

Sulphathiazole is used as a powder for the insufflation of wounds acting like all sulphonamides by combining with the *p*-amino-benzoic acid which the bacteria need for their growth. Mixed with one-halt its volume of penicillin powder it is a good application for infected wounds and for surfaces which are to receive skin grafts.

Sulphathiazole and *sulphadiazine* can also be used internally. They both act well against streptococci and pneumococci, against *Eschericheri coli* and gonococci, and less effectively against staphylococci. To be of any use there should be 2 mg. of these drugs per 100 c.c. circulating in the blood, and this maximum should be reached quickly. Give 1·5 gm. as an initial dose; 2 hours later 0·5 gm., and from this time every 4 hours 1·0 gm. and continue for 48 hours. For the next 2 days, which usually complete a course of treatment, the dose is reduced to 0·5 gm. every 4 hours. With these two drugs, but especially with sulphadiazine, serious ill effects are scarcely ever seen. Now and then a leucopenia occurs, which is not serious unless it is less than 3000 per c.mm. Much worse is agranulocytosis and anaemia. Sometimes a pyrexia occurs which disappears when the drug is withheld. Sulphathiazole may crystallise out in the renal tubules blocking them, or the crystals may collect and obstruct the ureter. For this, alkalisation of the urine is required and perhaps instrumental evacuation of the ureter.

Flavazole is a definite combination of proflavine and sulphathiazole. This is an antiseptic active against staphylococci, streptococci, diphtheroids, coliforms, *Bacillus proteus, Pseudomonas pyocyaneus* and *Clostridia.* Its action is not inhibited by proteins and it does not harm penicillin, so that the two substances can be combined. It is used as a 2 per cent mixture with sulphathiazole. If penicillin is desired it can be added to $33\frac{1}{3}$ per cent.

Boric acid is a mild antiseptic of use for inhibiting the growth of organisms in discharges when wet dressings are used. In wet boracic fomentations, for example, it is used to powder the lint if impregnated material is not at hand. For bathing the eyes boric acid is used in 1 in 40 solution.

Cetavlon or cetyl-trimethyl-ammonium bromide. It is a cationic detergent, whilst ordinary soap is anionic, so the two agents mutually

destroy each other. It is a powerful antiseptic. In 1 per cent solution it destroys very nearly all the bacteria on the surface of the skin. Hence, it is very useful in preparing the hands before operating and for the patient's skin. It is said that ordinary soap is more effective upon tissues exposed in a wound than cetavlon is. For large objects like baths and other utensils which cannot be boiled, cetavlon is an efficient antiseptic.

Penicillin.—This extraordinary product of the *Penicillium notatum*, discovered by Sir Alexander Fleming, is a near approach to the perfect antiseptic and has brought about revolutionary changes in surgical methods. It is an unstable salt of sodium or calcium, and works in inconceivably dilute solutions. It is completely harmless to the human body but cannot be usefully introduced by mouth as both the acids and alkalies of the alimentary canal destroy it. Solutions of its salts are also decomposed by contact with synthetic rubber. Except in dry powder form it must be kept in a refrigerator, or its potency will have largely disappeared by the end of a week. It can be administered by intramuscular injection continuously or intermittently, by inhalation, or it can be applied locally as powder, spray or cream. It is put up in pastilles for the mouth and lamellae for the conjunctiva. It does not pass very freely from the blood through synovial membranes or the pleura, therefore it is sometimes of advantage to inject it directly into a joint cavity or the pleural space. Very little indeed gets through the arachnoid membrane, so, for meningitis, it must be introduced by lumbar puncture. It works powerfully against staphylococci, streptococci (except the enterococcus), pneumococcus, gonococcus, meningococcus, the diphtheroid group, actinomyces, *B. anthracis*, *B. subtilis*, *Clostridium tetani*, *Clostridium Welchii*, *Clostridium septicum*, *Treponema*.

It does not affect the growth of the coli-typhoid-dysentery group, *B. proteus*, *B. pyocyaneus*, enterococcus, *B. influenzae*, Brucella group, Ducrey's bacillus.

Even amongst the usually susceptible microbes strains are found which are unaffected. Therefore, except in cases of emergency, before beginning treatment a test for susceptibility of the actual infecting organism should be made.

The product is standardised in Oxford units. Originally this was done by tests against a particular staphylococcus. The dose is measured in these units.

A continuous intra-muscular drip may be given by a simple gravity apparatus. The required dose of 120,000–240,000 units for 24 hours is administered in 100-200 c.c. of normal saline, a screw-clamp being adjusted to deliver the liquid at the required rate.

The needle is thrust obliquely, in the direction of the fibres of the vastus lateralis, through a pad of sponge rubber strapped to the outer side of the thigh. This serves to keep the needle in position.

A very clever electrically driven silent motor is sometimes used to move the piston of a syringe for constant administration. With this apparatus an exact dose of a concentrated solution can be given.

Intermittent administration is given by injecting into the gluteal region 20,000 units every 3 hours. This can be made painless if to the required dose be added an equal volume of 2 per cent procaine or 1 in 1500 nupercaine in 1 in 20,000 adrenalin. Systemic treatment as an average lasts for 5 days. The use of penicillin in various diseases will be described in later sections. (See also page 52.)

Hypertonic sodium chloride (4 per cent), introduced by Sir Almroth Wright, is a good application for recent wounds. It causes a great outpouring of lymph rich in protective substances and so calls forth the maximum natural powers of the body. The action is partly one of osmosis. Since sodium sulphate has a higher osmotic activity than sodium chloride, some surgeons prefer this salt. It is used in a saturated solution.

The Treatment of Infected Wounds

Operation wounds through non-infected tissue may be regarded as almost uncontaminated by bacteria. It is true that it is not possible to avoid all air and contact infection in any operation, but it is of such minimal amount that the natural defences of the body can deal with it. In the case of accidental wounds, however, the situation is quite different. The instruments by which such wounds are made have not been previously sterilised and dirt or mud may have been rubbed into the raw surfaces. However, during the first six to eight hours after a wound has been inflicted, the bacteria may be considered as being on the surface of the wound and as not having invaded the living tissue. That is, there is a distinction between a contaminated wound and a definitely infected wound. In the one the bacteria are lying on the surface and in the other they are deep in the tissues.

The treatment of accidental wounds therefore depends very largely upon the time that has elapsed since the wound was inflicted. In recently received wounds the surrounding skin is painted with iodine, or washed with cetavlon solution. The wound surface is thoroughly irrigated with normal salt solution. This mechanical cleansing of the raw surface with an inert solution is of very great importance. A satisfactory alternative is to clean the exposed tissues with ordinary soap and water Cetavlon is not suitable for this purpose. When

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should be used. The skin may have to be undercut to avoid tension. The surface of the wound, before closure, is again powdered with penicillin and sulphathiazole. If there is a space which cannot be closed by stitches, it is better to leave a small tube in it down which a few c.c. of penicillin solution (5000 units per c.c.) can be instilled twice daily. Systemic penicillin had better be given 2 days before and 5 days after secondary suture. Immobilisation is essential.

After 9 or 10 days conditions for secondary suture are not nearly so favourable, but may still be attempted if the granulations are smooth and regular, if the bluish line of advancing epithelium is present, if the skin is soft and pliable up to the wound edge and not inflamed. In these older wounds the margin of the new epithelium is excised and the skin undercut. In all cases where it is not possible to cover a wound with skin, grafting should be done at the earliest possible moment. In accidental wounds dealt with in the first 6 hours this grafting may take place at the primary operation.

As soon as a wound is fairly healed active use of the part should be encouraged. The suppleness of a scar may be helped by physiotherapy, especially by short-wave diathermy and sometimes by warm paraffin baths.

Skin Grafting

Skin grafts are said to be autogenous when a piece of the patient's own skin is transferred to another part of his body, homogenous when the skin is taken from another person and grafted on to the patient, and heterogenous when the skin of an animal is transferred to man. Heterogenous grafting is always a failure and homogenous usually. There is some doubt as to whether, in exceptional cases, a graft from one man to another can be carried out successfully. It is said to be possible to do this when the blood of the donor belongs to the same group as that of the recipient. For practical purposes the autogenous is the only useful method.

There are several methods of grafting skin:

(1) *Thiersch Grafts.*—In this method a thin layer of skin is removed with a knife to such a depth that the apices of the papillae of the corium are just cut across and appear as tiny bleeding specks. Such grafts may be of a very considerable area, measuring perhaps 2 or 3 inches across. They are usually taken from the surface of the thigh or the inner side of the upper arm. It does not really matter if the part of the skin from which the grafts are taken has hairs growing on it, because the deeper part of hair follicles are not removed and they are not reproduced in the grafted area. The surface to be grafted is sometimes a raw surface made at an operation which is

the cleansing has been completed, all grossly contaminated and all obviously devitalised tissue is cut away with the knife. If it were possible to excise the wound whole, almost certainly healing by first intention would be obtained. Too often the wound has penetrated into the neighbourhood of important structures, such as nerves and vessels, so that this wholesale excision is contra-indicated, but the careful removal of obviously contaminated shreds of tissue loses none of its importance. This débridement of the wound having been accomplished, another free irrigation is made. The wound can then be sutured with a definite prospect of healing by first intention. But before doing this it is a definite advantage to scatter over the raw surfaces a powder made of sulphathiazole 2 parts, penicillin 1 part. If the wound be of a limb, the member must be immobilised in plaster of Paris.

When more than six hours have elapsed since the infliction of the wound the situation is very different, because it is impossible to eradicate the bacteria which have now invaded the tissues. Here again, however, it is a great help to remove obviously contaminated and destroyed tissue. No such wound of this nature should be sutured. A few stitches may be placed to keep the parts in their approximately natural positions but the freest drainage is the best therapeutic measure. When dead and soiled tissue has been removed and the raw surfaces powdered the wound should be lightly packed with vaseline gauze. The limb is immobilised in a plaster. The microbe most commonly found in the early stages is the *Staphylococcus aureus*. The streptococcus only appears later and may not be prominent for a week or two. After a week or ten days diphtheroid bacilli are nearly always present. Systemic penicillin is given. During the first five days the wound is inspected to see if secondary suture is possible. The most favourable time for suture is about the fifth day. Microscopic examination of the wound secretions is not as good a guide as the appearances of the wound itself. The surrounding tissues should not be indurated and tender. The skin edges should show no inflammatory reddening. On the floor and walls of the wound are blood-clots, coagulated lymph, patches of fibrin, a mucoid yellow exudate, all of which are harmless but should be removed before suturing.

Contra-indications to closure are reddening of the skin margins, purulent discharge, induration and tenderness of the surrounding parts.

If the wound is sutured dead spaces should be obliterated by vertical mattress sutures of silkworm gut. No catgut should be buried in the wound. If vessels need to be tied, the finest cotton

solution the patient's blood is drawn. It is centrifuged, at first slowly in order to get a good buffy coat. The plasma is pipetted off and put on one side. Into 1·5 c.c. Tyrode's solution the buffy coat is transferred with a platinum wire and shaken up. With this cell extract containing thrombokinase, the deep surface of the graft is painted by means of a camel-hair brush. The recipient area is painted with the plasma. When the graft is applied coagulation quickly occurs and the graft becomes firmly fixed.

The inlay method of using Thiersch grafts is another procedure which is sometimes very useful, as for instance in correcting ectropion of the lower eyelid. In such a condition an incision is made below the eyelid, and the wound is caused to gape until the eyelid returns to its proper position. A cast of the little wound is then made with a small piece of stent which is surrounded by a Thiersch graft (the raw surface being outwards), and implanted into the wound, the edges of which are sewn together over it. In a week these retaining stitches are removed. The wound edges fall apart, the stent comes out and the operation is completed.

The area from which the grafts have been taken will very soon epithelialise up, but, as the papillae of the skin are cut across and the nerve endings are exposed, it is likely to be rather a painful area. These wounds are best dressed with a $\frac{1}{10}$-inch mesh netting which has been sterilised in molten vaseline.

(2) *Reverdin Grafts.*—In this method small discs of epithelium are removed by picking up the skin on the point of the needle so that it forms a small cone and cutting across the base. These grafts are thin at the edges and thicker in the middle where they go through the whole thickness of the epithelium. Reverdin grafting is a very certain method of bringing about epithelialisation of a wound surface. Many grafts must be taken, so that the resulting area has a spotted appearance in the end, a fact which makes it rather unsuitable for the face. In either Thiersch or Reverdin grafts the resulting area at first has a smooth, thin, shiny appearance which is insensitive to touch, and is dry because there are no sweat glands present. As time goes on the amount of subcutaneous tissue increases so that the graft becomes much more supple and approximates normal skin in appearance. Elastic fibres and nerve fibrils penetrate the sub-epithelial layer from the periphery.

An area covered with Reverdin grafts is best treated with perforated protective celluloid sheeting fixed in place with strapping round its edges. On the top of this a wet saline dressing is applied. The area from which the grafts are taken is treated as above.

(3) *Braun's Method* is really a special way of performing Reverdin's

immediately grafted, or sometimes it is a wound which has lasted for weeks or months and has refused to heal.

In immediate grafting it is important that all haemorrhage should be stopped before the graft is applied. This is best done by pressure if possible, because catgut ligatures beneath a graft always interfere with the growth of the epithelium in the region in which they are situated; so that it is a good plan *to remove the tumour or other* diseased tissue from the place to be grafted as the first procedure, and *to maintain pressure on it for some time* during the preparation of the graft, in order that haemostasis may be complete. In the case of old wounds it is important that they should be reasonably free from infection. The contra-indications to grafting are the same as those to secondary suture (page 14). *If streptococci are discovered,* the grafting should not be carried out until these organisms have been banished by powdering the raw area with sulphanilamide or penicillin for a few days. If granulations are very exuberant it is better to curette them away before applying the grafts. Thiersch grafts do not take over exposed tendons or bones. They are really suitable only when the bed is composed of muscle or connective tissue.

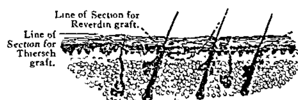


Diagram of skin showing the depth removed in skin grafting.

The next essential condition for successful grafting is that there should be exact apposition between the transferred epithelium and the bed, because the epithelium must depend for its nourishment on fluid exuded from this surface. Some surgeons recommend that the skin from which the graft is taken should be rendered hyperaemic by means of heat for a few minutes before actually cutting the graft, with the idea of increasing the store of food material in the transferred epithelium. After the grafts have been applied it is a good plan *to keep them in close apposition* with the surface below by means of a cast of the wound made in dental wax (stent). This cast is then kept in place by silkworm-gut sutures which run across it from normal skin on the one side to normal skin on the other. When the graft is a large one it is useful to suture the edges of the graft to the edges of the wound with the finest horsehair. The stent should remain in place for one week, when it can be removed and all stitches taken out. It will be found that the grafts have taken.

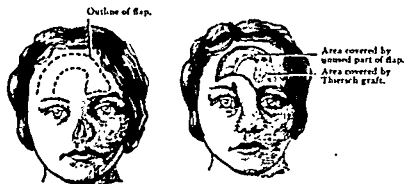
A very effective way to make grafts adhere and avoid the use of sutures is to stick them on with a glue made of plasma and fibrin ferment.

Into a 10 c.c. syringe containing 1 mg. heparin in 1 c.c. Tyrode's

The area from which the graft has been taken can usually be closed by undercutting and drawing the edges together with sutures.

(5) *Pedicle Grafts.*—A pedicle graft consists not only of the skin but of the subcutaneous tissues as well, and as such a graft if completely removed from its original situation would inevitably die, it is left attached on one side so that its vitality may be maintained until new vessels have grown in from the bed to which it has been transferred.

Such grafts are useful where tendons have been exposed, as, for instance, after the removal of a carcinoma from the dorsum of the hand, because, by their use, sufficient loose tissue is provided to allow



Sliding pedicle graft for reconstruction of nose.

their movement. In the case of the dorsum of the hand the graft is taken from the anterior abdominal wall, the area from which it is removed sewn together, the palm placed against the abdomen, and the pedicle of the flap brought up round the margin of the hand and sutured to the edge of the raw area. The hand and arm must be very carefully immobilised, which is best done by applying a plaster of Paris bandage. If the palm of the hand is to be grafted it is usually done by putting the back of the hand against the small of the back and making a pedicle graft in this situation. When the graft is firmly united with its bed, that is, in about 10 days' time, the neck of the pedicle can be cut across.

(6) *Tubular Grafts.*—Tubular grafts are a special variety of pedicle grafts by which the raw surface of the pedicle is avoided. In taking a tubular graft two parallel incisions are made and the skin and subcutaneous tissue between them raised up from the underlying muscles. The raw area is sutured beneath this flap, after which the two edges of the flap are folded underneath together and also sutured; so that the flap is converted into a tube, still fixed at each end. When these wounds have healed we have a structure like the handle of a bag or teapot. Round one extremity a piece of skin is marked

grafting. It is suitable for granulating wounds such as are found in the case of chronic leg ulcers.

Minute grafts are picked up with the needle, cut away with a scalpel, and then pushed into the depths of the granulations with the head of the needle. Such grafts are seeded all over the surface. A wet saline dressing is then placed on the surface of the wound, which is left for several days.

(4) *Wolfe Grafts.*—These are whole-thickness grafts. They are obtained by cutting away a piece of skin the exact size of the wound to be grafted, just down to the subcutaneous fat. Wolfe grafts can only be applied to wounds made at an operation. They will not take on granulating wounds. After a wound has been made and haemostasis attended to, a template is cut in either rubber tissue or thin sheet lead, and the graft made with $\frac{1}{8}$ inch margin all round. As the hair follicles and sweat glands are removed with the graft, care must be taken that a hairy area of the skin is not used where hairs are not desirable. As in Thiersch grafting, it is very essential that haemostasis should be perfect and that there should be close apposition between the graft and the bed. Some surgeons use rubber or sea sponges for pressing the graft down, others use stent. The *greatest care must be taken, however, that the pressure is not great* enough to obliterate the vessels underneath the graft which are to provide the necessary nourishment. The best method is to cut the graft and suture it carefully all round with horsehair stitches, and then make a stent splint corresponding to its size, which is held in place by the stitches which run over it in the manner described under Thiersch grafting. An improvement in this method is to cut out a frame from sheet celluloid which is about $\frac{1}{4}$ inch greater in its diameter than the wound and about $\frac{1}{4}$ inch in width. This frame is first sewn to the surrounding skin, then the stent is kept in place by strands of silkworm gut which run over the stent and under the frame on each side. The object in this case is to drag the surrounding tissue up towards the mass of stent, thereby relieving the pressure on the deep vessels instead of pressing the stent downwards and so perhaps obstructing them. After 6 days the stitches may be removed. Wolfe grafting done in this way is successful in the majority of cases.

Wolfe grafts are preferable to Thiersch grafts in situations where the appearance of the skin is important, such as the face. A Thiersch graft always remains a little conspicuous, whereas the full-thickness graft will eventually tone in with the rest of the skin and be almost imperceptible.

Wolfe grafts are also used after excising scars on the fingers or palm, though, here, pedicle grafting is often employed.

CHAPTER II

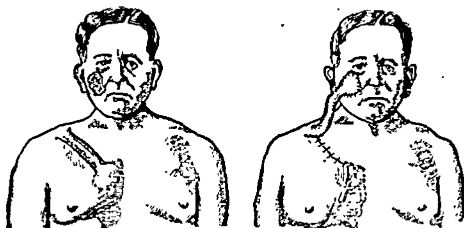
HAEMORRHAGE AND SHOCK

Haemorrhage

Loss of blood may arise from wounds of arteries, veins or capillaries. In arterial bleeding the continuous flow of bright red blood pulsates synchronously with the heart-beat. From veins the blood comes in a dark stream with no force behind it. Haemorrhage may not appear on the surface of the body. It may be concealed, as, for instance, when the haemorrhage comes from the intestine or takes place into the peritoneal or pleural cavity. A man can scarcely withstand the loss of 50 per cent of his blood at a single haemorrhage, though, if the loss occurs in small quantities over a long period so as to allow an adjustment, he can survive a considerably greater drain than this. Women withstand a rapid haemorrhage better than men. When much blood has been lost the patient faints. This syncope may lead to the arrest of the haemorrhage, because the feeble circulation allows time for the formation of a clot to plug the wounded vessel. As the patient comes out of his faint and the strength of the circulation increases, there may be a renewal of bleeding which again leads to fainting. These states of consciousness and syncope alternate until the patient dies. After a large haemorrhage, the patient is in great distress. He suffers from air hunger, making violent attempts to fill his chest with air. He may sit up to do this and the effort be too much so that he falls back in a faint. He is very restless, throwing his limbs about. He feels giddy. His vision fails or he may see black spots before his eyes, and he has a rushing sound in the ears. Yawning is rather characteristic. He complains of very great thirst but the thirst is not relieved by drinking. The skin is cold and waxy-looking, and moist with sweat. The pupils are widely dilated. The pulse is frequent, soft, small, often irregular and perhaps so feeble as to be undetectable.

Treatment.—The great principle of treatment is to arrest the haemorrhage from the bleeding point without delay. Sometimes

out which is the shape of the area to be grafted. It is raised and applied to this area, getting its nourishment through the tubular pedicle which has already been made. When the graft has certainly



Tubular graft for repairing a defect in the face.

taken, the pedicle is cut across. Such grafts may be moved from one side of the body to the other in successive steps. Tubular grafting is used, for instance, for transferring skin from the neck or chest to the face, in the formation of a new nose or repairing a cheek.

vein. It is usually better, however, to close the aperture with fine silk sutures.

The Treatment of Certain Forms of Haemorrhage.—In haemorrhages of the limbs temporary arrest can be brought about by pressure on *the bleeding point or by compression of the main artery* nearer the trunk. The brachial artery can be pressed against the shaft of the humerus, the axillary against the head of the humerus, the subclavian artery against the first rib, the popliteal artery behind the knee, the common femoral against the femoral head. A tourniquet will stop all haemorrhage below the level of its application. (See below.) In wounds of the palm, should the superficial arch be affected, the wound is opened up and both ends of the vessel tied. The same applies to wounds of the deep palmar arch, but to reach it a considerable dissection may be necessary. Great care must be taken to avoid injury to digital nerves or branches supplying the small muscles of the hand.

The treatment of wounds of arteries in general is described on page 62. The arteries which it is dangerous to ligate must be borne in mind. When, during the course of an operation, a vessel is divided in the depth of the wound where it is very difficult to see because of the rapid accumulation of a pool of blood, it is best, if possible, to arrest the haemorrhage temporarily by means of pressure against some bony point. Thus, if there is a wound of the renal artery or a ligature slips from the renal pedicle during a nephrectomy, the pedicle should be compressed against the vertebral column for ten minutes. At the end of this time so much contraction of the divided artery will have taken place that, when the compressing wad is removed, there will be perhaps only a trickle of blood. The vessel is easily seen and accurately seized in forceps for ligation.

Sometimes, after the extraction of teeth, bleeding continues for a considerable time. The best method of stopping this haemorrhage is to plug the socket with gauze and close the jaw upon the plug. If a fragment of muscle can be obtained it may be usefully employed as a plug. Or one of the preparations of thrombin may be effective, especially if used in conjunction with a plug. Or the gum may be sutured by a mattress stitch over the socket. Very rarely it is necessary to tie the external carotid artery.

Bleeding from the nose may be treated by irrigation with hydrogen peroxide. It nearly always ceases spontaneously. If it continues the nasal cavity should be inspected, when a bleeding point will usually be seen on the septum. It should be touched with a cautery. If the bleeding is occurring very far back plugging of the nares may be necessary.

this must be done temporarily and then steps taken to bring about some reaction towards recovery before permanent arrest is effected. Morphia is useful because it calms the patient and gives him rest. Heat should be applied to the body and saline solutions given. If he will absorb saline from the rectum this is a good way of administering it, but when the fluid must be introduced more rapidly, it should be given intravenously. Normal saline or, better, 5 per cent glucose in normal saline solution up to 500 c.c. is used. By increasing the volume of the blood the heart is allowed something to contract upon so as to maintain itsa ction. Ephedrine is sometimes useful because it constricts the peripheral vessels. But its use is associated with the danger of a lower blood-pressure when its effects wear off. Blood transfusion is the best of all remedies.

Haemorrhage from a wounded artery may be controlled by compression, by ligature, by suture, by torsion or by cauterisation. The ligature of arteries is referred to under wounds of arteries. If a vessel is in rigid tissue, such as the scalp, or a fibrous membrane, like the dura, retraction is not easy nor is ligation. It is best tied after underrunning it with a needle armed with sewing material, catgut or silk. In some situations suture of the soft parts is employed to stop haemorrhage, such as the over-sewing of the pedicle when a lobe of the lung has been removed.

Haemorrhage from bones must sometimes be controlled by rubbing into the cut surface Horsley's wax (beeswax, 7 parts; almond oil, 1 part; salicylic acid, 1 part). This method is used for stopping haemorrhage from the bone edges when the skull has been opened at an operation. In certain situations, such as the surface of the brain, it is technically difficult or almost impossible to ligate vessels. Bleeding from tissue of this kind may be stopped by applying a piece of freshly excised muscle, especially bruised muscle, to the site of the haemorrhage, which acts by virtue of its high content of thrombokinase.

Haemorrhage from a small vessel may be stopped by picking up its open end in a Spencer-Wells forceps and twisting it a number of times. This leads to rupture of the middle and inner coats within the adventitia, and to thrombosis. Torsion has sometimes been applied to quite large arteries. Haemostasis by cauterisation may be carried out by using the actual cautery at a red heat, or the coagulating diathermy current. Only small vessels can be controlled by this method. In stopping haemorrhage from an artery, it is usually necessary to ligate both ends.

Haemorrhage from veins can be controlled by very light pressure. Sometimes a lateral ligature can be used to close a tear in a large

a fall of blood-pressure and shock. The devitalising effect upon tissues which is reflected in an impaired resistance to infection has been mentioned.

Reactionary Haemorrhage

This is haemorrhage which takes place within 48 hours of a wound, either accidental or operative. It may be due simply to the patient's blood-pressure rising when he recovers from the shock, the increased blood-pressure forcing out clots which have temporarily closed the vessels. After an operation a large haemorrhage of this nature may result also from the loosening of a ligature, the result either of increased blood-pressure or movements of the patient.

If the haemorrhage is severe the wound should be opened and the bleeding vessel dealt with by ligature. During the first 24 hours after an abdominal operation it is sometimes very difficult to decide whether haemorrhage is going on or not, because the symptoms of haemorrhage are masked by those due to shock of the operation.

Secondary Haemorrhage

A secondary haemorrhage is a bleeding which occurs in a wound as the result of sepsis. It usually happens seven to ten days after the wound has been made. It is due to organisms digesting away the clots blocking the mouths of divided vessels. A secondary haemorrhage does not usually occur as a sudden profuse flow of blood. To begin with, there may be just staining of the dressings; then, after some hours, there will be a small trickle of blood, which may cease. Several such small haemorrhages are likely to occur and are usually succeeded by a massive loss due to the wide opening of the affected vessel. *If secondary haemorrhage should occur, treatment must be begun at the first sign.* The wound is opened up, the eroded vessel found and ligated and the wound disinfected. If possible, it should be left widely open, so as to provide free drainage. If the infective process continues in the wound, the whole sequence of events may be repeated, when again, as a rule, it is wise to explore the wound and tie the vessel. If there should occur another haemorrhage, and particularly if the haemorrhage has been great in amount, the ligature of the main vessel higher up must be considered. Such proximal ligation may be a very serious matter in the case of a limb, should the original bleeding vessel have been the main artery, for, if the main artery of a limb be tied in two places, there is a very strong risk of gangrene supervening. In exceptional circumstances amputation must be resorted to in order to save the patient's life.

The application of a wad moistened with 1 in 1000 adrenalin is often recommended to stop haemorrhage from a tooth socket or from a bleeding point on the septum of the nose. The disadvantage of this is that the temporary constriction caused is succeeded by a vasodilatation and the bleeding recurs.

Bleeding from the stomach is referred to on page 352. For haemorrhage from wounds of the lungs, see page 295.

Tourniquets.—A tourniquet is a constricting band applied to a limb to stop the flow of blood. In an emergency any material may be used, but in the operating theatre only rubber tubing, a flat rubber bandage (Esmarch's constrictor) or an air-inflated blood-pressure pad are used. The last has practically ousted all other tourniquets and is usually used in combination with an Esmarch bandage.

When a tourniquet is needed in a limb so damaged that it is certain that an amputation must be done, it should be placed as close to the wound as possible; in other cases it is better applied some distance from the damaged area. A tourniquet does more than control haemorrhage. It lessens shock because it prevents the great loss of plasma into the injured limb, and perhaps by preventing the absorption of shock-producing substances from the part. Indeed, sometimes a tourniquet is used without there being any need from the point of view of haemorrhage. For, applied above a wound infected with Clostridia, it will effectively prevent the upward spread of gas-gangrene. Morphia should always be given when a tourniquet is applied to lessen the pain it causes.

Many operations on the limbs are carried out under tourniquet haemostasis. The limb is elevated for 3 minutes to drain it of blood. The blood-pressure cuff is put round the arm or leg above or below the elbow or knee. Up to this level is applied an Esmarch bandage to squeeze out the remaining blood in the limb. Then the cuff is inflated to 70 mm. Hg above the systolic pressure and the Esmarch bandage removed. Anaemia in this way can be safely kept up for 4 hours unless sepsis is present, when the tourniquet must be released for 3 minutes every half-hour or resistance to the septic process will be very greatly diminished.

There are certain disadvantages in the use of tourniquets. Any, except the blood-pressure cuff, may, by pressure, cause paralysis of the nerves of a limb. Such tourniquet paralysis may last 2 or 3 months, though sensation returns earlier. Then damage to the skin at the site of application may occur. When a tourniquet is released after a long application, there may be a very considerable loss of plasma into the limb through capillaries which have been made more permeable by the anaemia. The loss may well be enough to cause

It is essential that the donor's corpuscles should not be agglutinated by the recipient's plasma. It is not so important that the recipient's corpuscles should be uninfluenced by the donor's plasma, because introduced plasma is so much diluted.

It will be seen from the tables that a group I individual can receive blood from all four groups. Group II is, of course, compatible with its own group and can also receive blood from the universal donor group IV, but is incompatible with the bloods of groups I and III. Group III, on the other hand, can receive blood from group III or IV, but is incompatible with groups I and II. Group IV can receive blood of its own group only. It is incompatible with the other three. If possible, the donor should be selected of the same group as the recipient. In every case, however, a direct test should be made of the compatibility of the selected donor's blood with that of the patient. This is done by adding a drop of the patient's serum to the donor's blood to test if agglutination occurs.

Blood can be stored if kept at 4° C., but begins to deteriorate after the fifteenth day. Such blood should always be filtered before use.

Following a blood transfusion there is very often a reaction in which there is a rise of temperature. Should an incompatible blood be administered, the patient feels a sensation of compression of the chest and pain in this region; he becomes unconscious, gasps for breath, and perhaps dies. In some extreme instances, where blood is slowly oozing out of the body, as from the erosion of a vessel in the base of a gastric ulcer, blood is transfused drop by drop. This drip transfusion may be carried out for a day or two, during which the patient receives enormous volumes of blood from a number of different donors.

Haemophilia

This is a condition in which haemorrhages take place very easily from the slightest injuries. Effusions occur into the joints and haematomata occur subcutaneously or in the muscles. It is a curious disease because heredity plays a very distinct part. The disease is transmitted through the females, who are not affected, to their sons. If a woman of a haemophilic family has many children, two-thirds of the girls will transmit the disease, and two-thirds of the sons will suffer from it. So that it is not invariably transmitted.

The tendency to bleed is seen in early childhood but if the patient survives to adult life the bleeding disposition grows less. Many children, however, fail to grow up. Bleeding may take place from a very trivial injury, such as a minute scratch on the surface of the

Blood Transfusion

When there has been considerable loss of blood the introduction of human blood from another individual has a great restorative action. Indeed, a moribund patient may, in a few moments, return to life. The blood may be transferred directly from one individual, the donor, to the patient, or recipient. This procedure is carried out by tying a cannula into the peripheral end of the donor's vein and another into the central end of the recipient's vein and pumping the blood from one to the other by means of a three-way syringe. Direct blood transfusion is, however, very seldom carried out as it is more convenient to bleed the donor and carry his blood in a receptacle to the patient. The blood from the donor is obtained by inserting a wide bore needle into one of the superficial veins in front of the elbow joint. 500 c.c. is the usual amount of blood to withdraw. This blood can be prevented from clotting by letting it run into 50 c.c. of 2·5 per cent sodium citrate, which will decalcify it, or the blood is run into a vessel which is shaken during the whole time it is being drawn and until it has been defibrinated. The blood is transferred to the patient by inserting a needle or tying a cannula into a superficial vein in front of the elbow joint or internal malleolus, to which is attached either a funnel and tube so that the blood can be introduced by the gravity method, or an apparatus by means of which the blood can be forced in by pressure.

In carrying out a blood transfusion it is absolutely essential that a blood compatible with the patient's blood be introduced. There are four blood-groups, labelled I, II, III, IV. Group I is said to be *the universal recipient group but this is not quite correct.* Group IV blood is compatible with all the other four groups if it is administered as the donor's contribution. Group IV individuals are said to be universal donors. If incompatible blood is administered the recipient's serum will cause agglutination and destruction of the corpuscles within his circulation. A serious reaction will take place from which the recipient may die. The following table should be studied because from it will be seen which donor's blood is compatible with which recipient's blood:

Moss	International	
	Serum	Corpuscles
Group I	O	AB
II	β	A
III	α	B
IV	αβ	O

Where serum and corpuscles designated by the same letter of the alphabet come in contact, agglutination and haemolysis will take place.

both cases there may be, after a short interval, a gradual return to normal. In the worse cases the state of the circulation slowly deteriorates and the patient dies.

There has been much speculation as to the essential nature of this curious condition. The neurogenic theory supposes that the strong stimulation of the afferent nerves leads to an exhaustion of the vasomotor centre. The fluid-loss theory postulates a great loss of liquid from the blood-vessels into the tissues. This would lead to a diminution in the quantity of the circulating blood, a general vasoconstriction with hurried heart action and feeble output. The theory of traumatic toxaemia supposes that, in the damaged muscles, some poison is produced which is directly responsible for the condition. The pathology of primary shock may not be the same as that of secondary shock. In the former the viscera may be found engorged and it may well be that excessive stimulation of afferent nerves may lead to the great fall of blood-pressure from exhaustion of the vasomotor centre, and thus be an important contributory factor. In secondary shock, however, all the vessels of the body are in a state of constriction, the splanchnic as well as the peripheral vessels. Experimentally it has been shown that the increase of weight of a crushed and swollen hind limb may amount to as much as 45 per cent of the total blood-volume. More plasma exudes than corpuscles. The red cells of course escape in the blood which is extravasated, but the capillary walls become more permeable to fluids so that the plasma pours out in excess and the blood becomes more concentrated and viscid. The rapid feeble cardiac action, the cyanosis and the low blood-pressure can all be explained by this loss of fluid.

The phenomena of shock are very similar to those produced by the injection of histamine. It was thus suggested that shock is due to the production of some poisonous substance in the muscles by the injury. There are several objections to this hypothesis. In the first place the post-mortem appearances after histamine shock are different in that the viscera are engorged with blood whereas in true shock they are pallid from vasoconstriction. A much greater loss of blood is required to cause the death of an animal in histamine shock, and most destructive of all is the fact that very little histamine or similar bodies is to be found in injured muscles.

When an area of the body is injured with local loss of fluid the body compensates for this by drawing fluid from the uninjured tissues of the rest of the body. If the organism has been already depleted of fluids by starvation, excessive sweating, vomiting or diarrhoea, shock will be more early in onset and more serious in intensity. Cold is another assisting factor, and indeed anything

body, and is seen particularly after tooth extraction or a tiny bite of the tongue. The bleeding is of the capillary type. It is a continuous ooze against which local styptics are of no use at all. The knee joints are those particularly affected. They suddenly swell up from effusion of blood in them after the most trivial injury. On other occasions, spontaneous haematomata occur amongst the muscles of the limbs. The pathology of the disease is really unknown. Clotting takes place, but slowly.

The treatment of haemophilia is extremely difficult. It goes without saying that no operation should ever be performed on a haemophilic individual if it can be avoided. The bleeding from large vessels is easily stopped by ligature. It is the capillary oozing which gives so much trouble. Sometimes inhalations of carbon dioxide will lead to local clotting and cessation of haemorrhage. Calcium lactate in 15 gr. doses, three times a day, may have some influence. The blood from another individual, if poured into the wound, may lead to clotting. Animal serum (any of the anti-sera obtained from the horse) soaked on gauze may help. Sometimes a hypodermic dose, 10 c.c., of horse serum, is effective. Another remedy is the introduction of thrombokinase into the wound. This is got by grinding up fresh liver and filtering it. Gauze is soaked with it and used as a pack. Kephalin, the residue of the ethereal extract of ox brain, is also sometimes employed. Other surgeons have recommended thyroid extract, in 5 gr. doses, three times a day. None of these remedies can be depended upon to stop the haemorrhage. Very often, in spite of all the surgeon does, the patient dies.

SHOCK

This is a condition of bodily weakness which comes on after great mechanical injury or severe haemorrhage. In it the patient lies pale, inert and limp, unconcerned with his surroundings, with shallow breathing and a rapid feeble pulse. The circulation is so poor that the hands and finger-nails may be of a dusky colour whilst beads of perspiration stand out on his face. He does not feel pain: indeed so anaesthetic is he, that, in this state, small operations can be performed without his being aware of it. He is not unconscious but will converse intelligently. When the condition comes on immediately after the injury it is said to be primary shock. Sometimes its onset is delayed for some hours. It is then said to be secondary shock. Compensation for loss of blood or plasma has suddenly broken down. The blood-pressure from being well up (150-170 mm. Hg) falls abruptly to 60 mm. Hg or even less. In

both cases there may be, after a short interval, a gradual return to normal. In the worse cases the state of the circulation slowly deteriorates and the patient dies.

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which stimulates the adreno-sympathetic system. It has been shown that the repeated injection of adrenalin in physiological amounts for two or three hours reduces the blood-volume very considerably. Long-continued vasoconstriction in an animal will, by itself, actually lead to a reduction in blood-volume. In shock there appears to be intense sympathetico-adrenal stimulation. One effect of this is the hyperglycaemia which is always found. It is thus clear that local loss of plasma must be a very important factor in the production of shock and that this is contributed to, particularly in primary shock, by excessive stimulation of sensory or sympathetic nerves, and perhaps by the absorption of poisons from the injured tissues.

Treatment.—This consists in the attempt to restore the volume of the blood, the application of warmth, the administration of cardiac stimulants, and the interruption of noxious afferent nerve impulses. An effective way of applying warmth is the hot-air cradle. As cardiac stimulants may be given brandy by mouth, strychnine hypodermically or 6 oz. of coffee by the rectum, though it is doubtful if any of these measures are of material use. It is more difficult to replace the volume of the circulating blood.

Blood transfusion is the most effective remedy against shock which might be expected. Blood-plasma or serum is better in pure shock apart from haemorrhage. A transfusion should be given whenever the blood-pressure becomes less than 90 mm. Hg. Blood should not be given at a rate greater than 100 c.c. per minute. Continue at this rate until the blood-pressure is normal, then maintain a drip. When the blood-pressure has been low for some hours transfusion will not raise it. These are the patients who succumb. Serious operations should not as a rule be undertaken in the presence of shock as the patient is likely to succumb to the added trauma and loss of blood. On the other hand, in some cases of progressive shock, as when a limb has been badly crushed, removal of the limb will put an end to the condition. The decision may require very nice judgement.

As a rule the blood-pressure should be 100 mm. Hg or higher for an operation to have a prospect of success.

In spite of the apparent need oxygen appears to be no good in shock. But of course it is wanted in chest injuries or where there is pulmonary oedema. In the case of burns and perhaps in simple shock, large quantities of isotonic sodium lactate (2 per cent) by mouth help to restore the blood-volume. It will not do so if given intravenously. Perhaps in passing through the liver it causes the release of proteins into the circulation.

Morphia is of distinct use in shock. It is best to give $\frac{1}{6}$ grain intravenously.

Crush Injury

This is a peculiar condition seen in patients who have been pinned for several hours under the wreckage of bombed houses. When rescued, shock is present, but this disappears under treatment. The patient seems to have recovered, except for a swollen limb, or even with no swollen limb but a little bruising of the trunk. Then renal failure comes on which leads to death in about 7 days.

The first sign is the passage of pigmented urine. Then the damaged limb becomes swollen and hard. Petechial haemorrhages and blisters may appear. Patchy anaesthesia is found and there is usually paralysis. Gangrene may or may not occur. Mental apathy comes on with vomiting and a rise of blood-pressure above normal. The urine is greatly diminished and there may be pain in the loins. By the end of a week if recovery takes place a sudden diuresis is seen and the patient returns to normal; or the uraemic condition becomes intensified leading on to death.

It has been suggested that the renal failure is due to damage of the renal tubules by myohaemoglobin, set free from the damaged muscles. There is some experimental indication that alkalinisation of the urine may prevent the noxious action. Hence treatment consists in giving alkaline drinks in large quantities (3 litres daily of sodium citrate, 3 gm. per 30 c.c. flavoured with citrus juice or peppermint and glucose), coffee, tea and, if necessary, morphine. Intravenously 3·8 per cent sodium citrate or 2 per cent sodium lactate may be given. The urine must be made alkaline to dissolve the muscle pigment in the renal tubules. As there is retention of potassium in this condition, potassium salts should not be given. Shock is treated in the ordinary way as is the injured limb.

CHAPTER III

INFECTIONS WITH PYOGENIC BACTERIA

General Septic Infection

Under this heading are included sapraemia, septicaemia and pyaemia. Sapraemia results from the introduction into the circulation of poisons generated in some septic focus in the body. No bacteria are found in the blood-stream. In septicaemia the organisms from the septic focus not only gain access to the circulating blood but proliferate therein. In pyaemia there has occurred somewhere in the body a septic venous thrombosis from which portions of the septic clot containing organisms have become separated and been carried by the blood-stream to distant regions.

Sapraemia

A well-known example of this condition is the poisoning which results from the decomposition of retained products of conception after an incomplete abortion. Within the uterine cavity there is a mass of dead, putrefying, stinking tissue from which toxins gain entry into the blood-stream. Sapraemia may also occur from surgical wounds, for instance when in an amputation the wound has been sewn up without sufficient drainage, and sepsis has occurred. Surgical fever, that is, the fever which accompanies a septic wound, is in reality a mild form of sapraemia.

A patient suffering from sapraemia shows a general depressive disturbance of all the functions of his body. There are great exhaustion, weakness and loss of energy. He has headache, malaise, and pains in the back and limbs. His temperature is high but he does not usually have a distinct rigor. The mouth is dry and the tongue coated. The pulse is rapid and weak. The alimentary canal is upset, for he has nausea, vomiting and usually diarrhoea. He becomes restless and, at night, is delirious. The kidneys do not function properly, so that there is a diminution in the amount of urine, which may contain

casts and albumen. The patient looks anaemic and is actually so, because of the destruction of the red corpuscles. Jaundice may be due to this or to a cloudy swelling of the liver cells. Perhaps the petechiae, so often seen in the skin, have a similar origin in the disintegration of erythrocytes. There is always some focus in the body where putrefaction is taking place.

In the treatment of the condition the primary need is to eliminate the septic focus and provide free drainage to the exterior for the products of decomposition. In severe cases it is right to remove the focus of infection. If this be done and the patient is not too severely poisoned, recovery will take place. At the same time, the elimination of poison can be helped by the administration of purgatives and the intravenous infusion of salt solution. The patient's strength must be maintained by easily digestible food and a watch should be kept for complications which may arise. These are very numerous and include enteritis, hepatitis, nephritis, endocarditis, broncho-pneumonia and peritonitis.

Septicaemia

In septicaemia there must, of course, be a primary source of infection such as a septic wound from which the organisms have gained entry into the blood-stream, but this wound may be quite small and sometimes is actually undiscovered. Septicaemia can also occur from such inflammatory affections as tonsillitis, otitis media, posterior urethritis or prostatitis, or even dental sepsis. Organisms which can be recovered from the blood are most commonly streptococci, but sometimes staphylococci are found and less commonly pneumococci, or the *Bacillus coli*. Gonococcal septicaemia is very rare. The bacteria get into the blood-stream by passing along the lymphatics so that, if septicaemia results from a septic infection of the hand, it is usual to see red streaks passing up the limb towards the axillary glands which are enlarged.

The symptoms are very similar to those of sapraemia but the disease, as a rule, begins with a rigor. There is very great prostration, which may be felt even before the chill. Should the patient succumb to the disease the symptoms which have been mentioned under sapraemia will be noted, and the patient will pass into stupor and ultimately coma. Twitchings of the muscles are frequently observed (subsultus tendinum) or the patient picks at the bed-clothes (carphologia). He assumes a Hippocratic facies, with a hollow face, sunken eyes, prominent cheek-bones, pinched nose, livid hue and relaxed lips covered with sordes. He frequently suffers from hiccough. His general condition deteriorates and he dies from exhaustion. In septicaemia

the anaemia is very pronounced. There is visceral congestion which may go on to actual infections; meningitis, endocarditis, peritonitis. Broncho-pneumonia is common. The spleen is enlarged. The organisms are apt to settle in the parotid gland, causing an acute parotitis; in the bones, causing osteomyelitis; or in the joints, causing an acute arthritis. Sometimes abscesses form between the muscles, particularly those of the thigh. The organisms can be recovered from the blood-stream.

In the treatment of this condition it is vitally essential to remove, if possible, the originating source of the infection or, if this is not possible, to provide the freest drainage. For the disease itself, it has not been possible in the past to apply a directly curative agent, but now sulphadiazine and penicillin (local and systemic) offer hopes of cure when the disease is due to a susceptible organism. Blood transfusions help the patient to resist the infection and it is claimed by some pathologists that immuno-transfusions are better. That is, a healthy donor with compatible blood is first inoculated with a vaccine made from organisms found in the patient's blood. The donor is bled on the fourth or fifth day after inoculation when it is supposed that his immunity against the organism is greatest. The patient's strength must be maintained as far as possible by light nourishing food, and complications, such as arthritis, must be dealt with as they arise. The prognosis in septicaemia is always very serious.

Pyaemia

In pyaemia there must have been a septic focus which has caused thrombosis of a neighbouring vein. It is likely to occur in osteomyelitis, because the bone marrow has such large thin-walled vessels, which, the marrow space being inextensible, almost invariably become thrombosed. Inflammation of the mastoid cells may spread to the lateral sinus, or a carbuncle of the face affect the facial vein, the inflammation of which spreading along the angular and ophthalmic veins reaches the cavernous sinus. Thrombosed varicose veins occasionally become septic and lead to pyaemia. Inflammation of the appendicular vein in acute appendicitis may spread to the ileocolic veins and so give rise to portal pyaemia. In this disease the clot in the vein becomes softened by bacterial activity and so small fragments of it become loosened, are swept off in the blood-stream and lodge either in the lungs or in parts of the systemic circulation. Particularly are emboli found in the spleen, the kidneys and the pericardium. The parotid gland, just as in septicaemia, is likely to become inflamed.

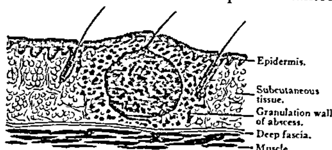
The general condition of the patient in pyaemia is similar to that in sapraemia and septicaemia, but the separation of small clots and their lodgement in the organs gives rise to severe rigors and pain in the organ affected, for instance, in the lungs or in the spleen. The range of temperature is also extreme in pyaemia. The wound has usually an unhealthy appearance and is often dry and brownish.

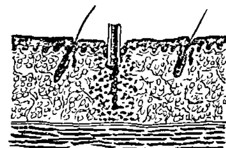
In addition to the treatment which is useful in septicaemia it is sometimes possible to prevent further ingress of septic clot into the general circulation by the ligature and division of the thrombosed vein beyond the inflamed area, so that in lateral sinus thrombosis the jugular vein in the neck is tied. In the case of carbuncles of the face ligature of the angular vein has been recommended as a prophylactic measure (see pages 40 and 78). It has even been recommended in cases of septic appendicitis that the ileo-colic vein should be ligated, but this appears to be an extreme and unnecessary measure. If a clotted varicose vein be the cause of pyaemia the internal saphenous should be ligated and divided at the upper end of the thigh. The treatment of pyaemia is the same as that for septicaemia.

Abscess

An abscess is a newly formed cavity containing pus. It is due to infection with pyogenic organisms, the staphylococcus and streptococcus most commonly, but sometimes the *Bacillus coli*, the pneumococcus or the *Bacillus typhosus*. A fully formed abscess cavity has a wall composed of granulation tissue outside which there is a zone infiltrated with leucocytes. The cavity of the abscess contains pure pus or perhaps pus and shreds of dead tissue. It is formed by the deposition of the exciting organisms which set up a focus of inflammation to which leucocytes are attracted by the chemiotactic properties of the bacteria. The microbial toxins cause death of tissue elements, which are then liquefied by the action of a proteolytic ferment secreted by the leucocytes. It is possible that some organisms themselves have a directly lytic effect upon the tissues. It is thus that a space is formed around which there is a zone of acute inflammatory reaction. The organisms attack the walls of the space, causing liquefaction in successive layers, thereby enlarging the cavity until they are destroyed by the body, or such a resistance is put up that they are unable to progress further. Some tissues liquefy more easily than others, so that an abscess is often limited by a layer of dense fascia. Thus, a boil or carbuncle does not get through the deep fascia into the muscles but gradually eats its way through to the skin surface. When the surface is reached the superficial layers die and perforation results.

After the spontaneous discharge of pus or its evacuation through an operative incision, the walls of the abscess cavity fall into contact with each other. The lining granulations coalesce and the cavity becomes obliterated. The pus contained in an abscess may be of the consistency of cream as in the usual staphylococcal infection, or it may be much thinner as is often seen in streptococcal lesions. It may be very foul-smelling if the *Bacillus coli* is present or blood-stained from rapid destruction of the tissues and the solution of the walls of small vessels which are unable to clot in time to prevent blood escaping.





An abscess in the subcutaneous tissue arising from a hair follicle infection. In the lower diagram the abscess has been drained and its walls have collapsed to obliterate the cavity.

The treatment of acute abscesses is very simple. As soon as pus has collected the surgeon can be quite sure that there is a barrier of protective granulation tissue set up around the focus of infection. He can then with impunity incise the overlying tissues and evacuate the pus without there being a danger of spreading the infection. When the pus has been let out and drainage provided by means of a rubber tube or rubber tissue, the inflammatory process soon ceases, *the cavity collapses and, the walls coming together as described above*, the lesion heals.

A *Furuncle* or *Boil* is due to the infection of a hair follicle with the *Staphylococcus aureus* or sometimes the *Staphylococcus albus.* These microbes can only get a footing in the tissues when the resistance of the patient is lowered. The intricate mechanism of immunity is unknown, but resistance is likely to become lowered to staphylococcal invasion if the patient suffers from Bright's disease or has diabetes. It is said that a diet containing excessive carbohydrate predisposes to abscess formation. The infection starting in the hair follicle is so acute that liquefaction of the tissue cannot keep pace with the spread of the necrosis. In a fully formed boil there is therefore a central core of dead tissue surrounded by a collection of pus.

Boils are likely to form particularly on the back of the neck, the back of the thorax and, in rowing men, the buttocks. First a red papule forms with a hair projecting from its summit. It is exquisitely

tender. The inflammatory induration round it gradually increases for about seven days, by about which time the pus will have reached the surface and be discharged. Boils are usually a mild malady but occasionally they lead to the thrombosis of veins and pyaemia, or cause metastatic lesions in bones, the brain or kidneys. The brain has very little resistance to septic infection. In the kidneys the lesion is situated just under the capsule where a small abscess forms which may very likely rupture into the perinephric tissues and lead to the formation of a perinephric abscess.

In the treatment of boils great relief can be derived from the application of heat. Moist heat is better than dry heat, so that hot fomentations are frequently recommended. The only objection to them is that sometimes they lead to the formation of minute pustules in the skin around the boils, due to inoculation of the pus. This can be avoided to some extent by smearing the skin all round the areas with ung. hyd. ammon. dil., ung. hydrarg., or penicillin cream. In refractory cases penicillin should be given intramuscularly (page 12). If there is much pain the course of the disease can be shortened by incising the boil under anaesthesia and removing the core. After this fomentations certainly give relief.

Carbuncles

A carbuncle is an infection of the skin and subcutaneous tissue which takes place through a hair follicle. It is due to the staphylococcus and is really a collection of boils. Running up through the dermis from the subcutaneous tissue to the sebaceous glands and hair follicles are columns of fat called columnae adiposae. This tissue is less dense than the dermis so the infection from a hair follicle spreads down the column into the subcutaneous tissue. It does not penetrate the deep fascia but spreads laterally where it meets other columnae adiposae, by which the infection spreads again towards the surface of the skin. The result is a hard brawny mass of inflamed subcutaneous tissue with a number of foci of suppuration containing cores of dead tissue. These suppurating foci ultimately reach the skin and break through, so that a carbuncle has a number of discharging apertures in contrast with a boil which has only one. The area of a carbuncle may be very great. At the back of the neck it may spread from ear to ear, and at the back of the trunk an area as much as 6 inches in diameter may be involved. If a cut is made into the lesion sloughs will be found and perhaps widespread burrowing under the dermis.

Carbuncles are much more serious affections than boils because of the greater area of tissue involved. Patients are often very run-down; they may have diabetes. The pain is often intense, there is a rise of

temperature; perhaps, at the beginning, a chill. The large hard raised area has a dull reddish colour, which becomes bluish at the spots which ultimately necrose and form apertures for the discharge of the pus.

There may be serious complications, such as septicaemia and pyaemia from venous thrombosis, or perhaps secondary haemorrhage from an artery.

A carbuncle takes about ten days for formation before it reaches the surface and discharges, but the whole course of the disease before healing is completed may last for seven weeks or more. A patient with a carbuncle often has a much lowered resistance to the staphylococcus which persists for a considerable time so that he is liable to have a succession of similar lesions, spreading perhaps over one or two years. Ultimately, however, his resistance returns to normal and the susceptibility to attack disappears.

The common sites for carbuncles are the back of the neck and the back of the trunk. Small carbuncles are often seen on the back of the first phalanges of the fingers. On the face, carbuncles are found

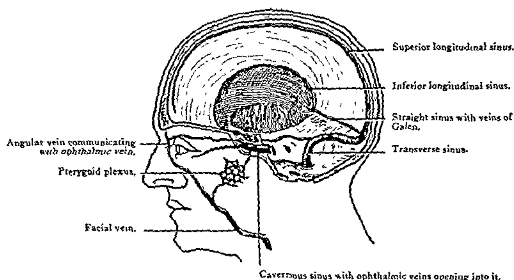


Diagram to show how infection on the face can reach cavernous sinus by communicating veins.

more particularly in the region of the lips and the cheek. A facial carbuncle is a very serious affection. The mortality from them is high. This is because the facial vein becomes thrombosed and the septic process spreads by way of the angular vein and the ophthalmic veins to the cavernous sinus or through the pterygoid plexus to the same sinus, the result being cavernous sinus thrombosis, which very often ends in death. It has been said that the liability to invasion of the facial vein is due to the great mobility of the facial muscles in expression and speech, but when a carbuncle forms on the face, the muscles and tissues are so much infiltrated that all movement is lost.

It is more probable that it is because of the absence of deep fascia separating the subcutaneous tissue from the muscles of the face with their abundant vascular spaces that this invasion occurs.

Treatment.—Just as in the case of boils, it is essential to determine whether the patient is a diabetic or not. If he is, his glycosuria should be controlled by diet or the administration of insulin. The carbuncle itself may be treated by the application of fomentations. Some surgeons recommend the application of gauze soaked in the following mixture:

Saturated magnesium sulphate solution .	40 parts
Glycerin	10 „
Boiling water	30 „

This is a hypertonic solution and is thought to encourage osmosis and to bring serum with high anti-body content towards the lesion. The patient is best kept in bed. Penicillin systemically is the best treatment (page 12). With this the acute pain quickly subsides, softening occurs and the sloughs are extruded.

The question of the operative treatment of carbuncles is debatable. In the infiltrated tissues there is very great tension which may lead to considerable pain, and this can certainly be relieved by making a crucial incision right across the carbuncle from one border to the other: or, if the lesion be very large, a number of parallel incisions may be made. Cavities containing pus surrounding necrotic tissue will be opened by these incisions and should be packed with gauze soaked in the magnesium sulphate solution. Some surgeons recommend the excision of the whole carbuncle, but this is a needless sacrifice of skin from which regeneration of epithelium can occur, and it does not lead to any quicker cure of the patient. Other surgeons have recommended the use of diathermy to destroy the infected tissue. The objection to this method of treatment is, again, the needless sacrifice of tissue and the sealing of lymphatics which are bringing to the part plasma containing protective substances. Other surgeons hold that no manual interference with a carbuncle is called for or desirable, because there is some danger of disseminating the infection by incision. This may be true if there is much disturbance to the part when the incision is made or if the necrotic tissue is curetted away, but there does not seem to be much danger of dissemination from a simple incision. Most surgeons hold this view in the treatment of facial carbuncles and insist on the danger of operating in such cases. It is not easy to get reliable evidence on such a point because of the difficulty in obtaining parallel series of cases of such a rare condition. Certainly the incision of a facial

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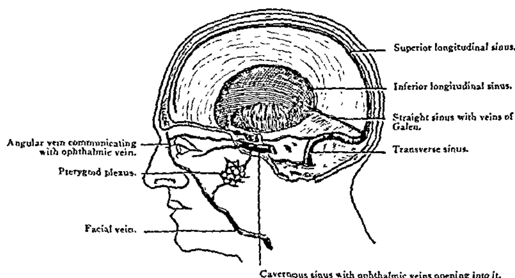


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In the treatment of cellulitis it is very essential to give rest to the affected part, which should therefore be placed in a splint of some kind, the patient being in bed. Heat in the form of fomentations gives the most relief. The patient's strength should be kept up by an easily digested nourishing diet and the excretion of toxins aided by giving purgatives and large quantities of fluid to flush the kidneys. If the infection is due to susceptible organisms, penicillin treatment should be instituted. Sulphadiazine may be useful (page 11).

Incisions should not be made in an area of cellulitis unless they are necessary to give exit to collections of pus or to expose cavities in which sloughs lie; or sometimes to relieve very great tension thereby preventing necrosis of the tissues. After incision boracic fomentations can still be used, or the wounds can be dressed with the magnesium sulphate solution.

Chronic Cellulitis (Ligneous Phlegmon; Ligneous Inflammatory Infiltration)

This condition is not very common. It occurs in people of fifty years of age or over and affects the neck more particularly than elsewhere. It is due to a chronic staphylococcal infection of the cellular tissue which leads to the formation of much fibrous tissue, so that the neck feels in hardness almost like wood. The condition begins in a circumscribed area but slowly spreads and persists for a period of weeks. It interferes with the movements of the muscles of the neck and may actually compress the trachea or even lead to dysphagia. After some weeks the skin may become a reddish violet colour and oedematous. As a rule pus forms only in very small quantities. Occasionally abscesses develop. The infection may be derived from the mouth or the pharynx, or spread from an infected salivary gland.

The condition is very difficult to distinguish from sarcoma of the fascia of the neck as there is not likely to be a temperature and there is very little tenderness. The diagnosis perhaps can only be made by removal of a piece for microscopic examination.

This ligneous phlegmon occurs occasionally around the kidney in the perinephric tissues, or in the perineum, where it is due to chronic extravasation of urine. It is also sometimes seen in the abdominal wall. In the neck it can cause death from oedema of the larynx.

Treatment is not very effective in cutting short the disease. Fomentations are usually employed. Vaccines should be given and, if collections of pus form, they should be evacuated. Penicillin or sulphadiazine should be tried.

carbuncle has sometimes led to the recession of the inflammatory process. If incisions are made, however, care should be taken not to divide a large vein or to interfere with the branches of the facial nerve.

In order to prevent cavernous sinus thrombosis, the angular vein at the side of the nose is sometimes ligated. Whilst this, theoretically, might prevent sepsis passing into the cavernous sinus by the upper route, it would have no effect on that by way of the pterygoid plexus, and the great difficulty is to select those cases in which it is necessary to do it. It is obviously only required when the facial vein coursing over the face is actually thrombosed, but we have no easy means of determining this. If the operation be carried out as a routine it may cause sepsis in a hitherto uninfected area of the face and the necessary dissection actually lead to the complication which it is desired to prevent.

In all severe staphylococcal infections, where the toxaemia is great and the temperature high, an anti-staphylotoxin should be administered. It has been already said that the resistance to the staphylococcus in patients with carbuncles and boils often remains at a low level over a long period. Attempts should be made to increase the resistance by the injection of staphylococcal vaccines and staphylococcal toxoid.

Diffuse Cellulitis

Cellulitis is the name given to an infection of the cellular tissue, which lies under the skin and between the muscles, with the staphylococcus or the streptococcus. The organisms gain entrance into the lymphatic spaces through some wound of the skin which, however, may be very minute and overlooked. The result of the invasion is an infiltration of the tissues with round cells and the filling up of the lymphatic spaces with lymph. There is considerable oedema. Here and there are places in which the inflammation is more intense, so that pus collects in cavities; or areas of tissue necrose. The inflammatory lesion may spread from the subcutaneous tissue to that between the muscles, reaching perhaps right down to the bones. In the hands it invades the tendon sheaths. Running up the limb, if an extremity is affected, are tender red lines due to the inflammation of the lymphatic vessels (lymphangitis). The affected area is of a dusky red colour and much swollen. It may be brawny and oedematous. It pits on pressure. At the beginning of the illness there is often a chill. The temperature is high and the patient sweats. He has headache, malaise and anorexia. The neighbouring lymphatic glands are enlarged. Any of the serious complications of staphylococcal infections may occur, such as metastatic infections of the joints, bones, brain or kidney; or septicaemia may supervene.

The spores of the tetanus bacillus may lie dormant in a wound for a very long time and be lighted up into activity by some subsequent disturbance. For instance, they may be in a compound fracture and remain after the fracture has healed and then grow at a subsequent operation for correcting a deformity of the bones.

There is an incubation period which varies from three to twelve days. At first there is a restlessness noticed, inability to sleep and headache. There may be some frequency of micturition and pain in the wound. Then there often occur local twitchings and spasm of the muscles of the affected limb. The muscles of the jaw, the neck and the face become contracted so that the patient cannot open his mouth. The risorius muscle, pulling the angles of the mouth outwards, gives him a ghastly fixed smile, whilst the frontalis muscle draws the eyebrows upwards. Deglutition becomes difficult and soon the abdominal muscles become rigid. The tonic contraction of the muscles is permanent, but from time to time the patient passes into attacks of severe clonic spasms of the muscles. When this occurs his jaws become strongly clenched, the smile on his face (risus sardonicus) becomes more pronounced, his limbs and body go into violent contraction. The dorsal muscles, being stronger than the abdominal muscles, gain the ascendancy so that in the fits the patient's body may rise from the bed and be supported only by the back of the head and the heels (opisthotonos). At the same time, owing to spasm of the diaphragm and the intercostal muscles, and contraction of the laryngeal sphincter, all breathing ceases. The patient becomes cyanotic. He froths at the mouth, sweats and usually gives an unearthly scream as by the forcible contraction of the thoracic muscles the air is forced through the nearly closed glottis. The contractions of the muscles may be so violent that a spontaneous rupture of the rectus abdominis occurs. During these attacks the mind of the patient is quite clear though he is powerless to make any movement or alter his expression. The frequency of these fits varies according to the severity of the disease. Only two or three a day may occur or they may happen in almost continuous succession. During all this time the patient shows a hypersensitiveness of hearing and vision. Bright lights or loud sounds may actually excite the spasms. He sleeps very little. The temperature is slightly raised. Sometimes the disease, when it starts from a lesion of the head or face, is accompanied by facial paralysis and spasms, particularly of the neck and pharynx, so that deglutition is impossible. The third nerve is also sometimes paralysed. This is called cephalic tetanus. All patients with tetanus have great difficulty in swallowing, as the initiation of the act sends the muscles of deglutition into contraction, and most of them

CHAPTER IV

TETANUS

The tetanus bacillus is rather widely disseminated in nature. It is found in soil, particularly soil of ground which has been used for grazing, as the bacillus is a normal inhabitant of the alimentary canal of cattle and horses. It is also found in the alimentary canal of man. Infection by tetanus takes place through a wound of the skin or mucous membrane, but the wound may be very small, the mere puncture of a thorn or a needle. The introduction of tetanus bacilli into the tissues does not necessarily mean that tetanus will result. There must be accessory factors coming into play which assist in breaking down the resistance of the organism. Thus, it is more common in putrefying wounds and where there has been an extensive crushing damage to the tissues. A splinter assists in infection because the spores may lie in interstices where the leucocytes cannot penetrate and so have a chance of germinating. Certain substances seem to assist in the growth of bacilli. Tetanus has been rather frequent following injections of gelatin, and injections of quinine, which is negatively chemiotactic for leucocytes. Infected catgut or septic abortion may likewise be the origin of tetanus, and it sometimes occurs in infants from infection of the umbilical cord (*Tetanus neonatorum*).

The bacilli remain localised in the wound and do not disseminate over the body. The symptoms of the disease depend upon the absorption of toxin from the infected site. This toxin is extremely powerful, the minutest dose being capable of causing death of a patient. It is elaborated in the wound and travels up the motor nerves until it reaches the spinal cord where it attacks the anterior ganglion cells, causing them to discharge impulses and throw the muscles into spasm. Some of the toxin is absorbed by the lymphatics and gets into the blood and so reaches other motor nerves by which it travels to other parts of the central nervous system. The poison, once it has entered into combination with nervous tissue, is very strongly fixed. It is impossible to break down this combination by any known means.

drainage being provided. The limb should be fixed in a splint. The patient should be kept in a room which is quiet and dimly lighted. All manipulation possible should be avoided. Even the bed-clothes should be kept from contact with the body by being supported by a cradle. Feeding presents a difficulty. The patient can only take fluids because of the spasm of his jaws. It is the convulsive fits which kill the patient by exhaustion or respiratory spasm. Attempts should be made to control these, but it is very difficult to do so. Recently avertin has been employed for this purpose, given rectally in doses of 0·07 to 0·1 c.c. per kilo of body weight. Relaxation of the muscles follows for about six hours, when the dose may be repeated. Very large numbers of doses have been administered without harm, and cure has resulted, but it must be remembered that avertin in repeated doses does give rise to fatty degeneration of the liver. Avertin also makes the respirations shallow. Any cyanosis due to this cause may be relieved by the administration of oxygen through the nose.

Paraldehyde per rectum, 1 to 6 drachms in twice the quantity of water, is also useful in controlling the spasms. In very severe cases chloroform must be used. Morphine is not so good because it is a respiratory depressant. Another drug which has been used and is under trial is curara. It abolishes the action of the motor end-plates. Any nursing manipulation which is necessary, such as catheterisation, should be carried out on the patient when he is most deeply under the influence of avertin or paraldehyde.

When there is any possibility of infection with tetanus, in such cases as road accidents, compound fractures, in which the wounds are soiled with earth, a prophylactic dose of antitoxic serum should be given hypodermically. For this purpose 3000 International units (equal to 1500 American units) are sufficient, but it is as well to repeat the dose in seven days.

There is another prophylactic method: that is, the production of active immunity by the injection of tetanus toxoid. This is simply a formalin-treated toxin. Two doses must be given at an interval of not less than four weeks. After this a high antitoxic power is found in the blood.

have retention of urine. In acute cases the patient is usually dead within five days, that is, in about 85 per cent of all cases of tetanus. A hyperpyrexia, of 108° or 110°, usually precedes the fatal issue. Death occurs in one of the spasms from cardiac or respiratory failure. In these patients the incubation period is short. When it is longer, ten days or more, there is a much greater chance of recovery. All the symptoms are milder. The spasm may last for two to three weeks with infrequent fits which become less in severity and finally disappear.

There is another factor which is of importance in estimating the prognosis, and that is the time that elapses between the first onset of symptoms and the first convulsive fit. If this is more than two days, and added to the incubation period, it makes more than nine days, recovery usually occurs. It is vitally important to begin treatment at the earliest possible moment.

The treatment consists in the administration of antitoxin. There is some difference of opinion as by what route the remedy should be given. It may be injected into the veins, into the subcutaneous tissues, or into the thecal space. The administration by lumbar puncture is probably not so effective as it would appear at first sight, because the toxin which is already associated with the nerve cells is so firmly fixed that it is impossible to break down the combination, and also it is not certain that foreign substances put into the thecal space will reach the nerve cells. There is some evidence to show that they must be first absorbed into the blood-stream and carried by that route to the spinal cord. The toxin which has become fixed in the nerve tissue has done its work and seems to be beyond control. The object of antitoxin is to neutralise toxin which has not yet become fixed, which may be in the circulation or may be in the neighbourhood of the wound. This seems best accomplished by injecting the antitoxin intravenously. The next question which arises is whether a single or repeated doses of antitoxin should be given. Investigations in animals have demonstrated the presence of considerable quantities of antitoxin in the blood-stream even a fortnight after its administration. They indicate that it is sufficient to give one large dose rather than repeated smaller doses. So that it can be recommended with some confidence that a single intravenous administration of 200,000 units should be employed. The wound should receive treatment but not until the antitoxin has been administered for some hours, as any interference with the wound may cause rapid absorption of the poison. One hour before the operation it is a good plan to inject around the wound 10,000 units of antitoxin. It should be opened widely, damaged tissue removed,

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CHAPTER V

SYPHILIS, CHANCROID, GRANULOMA VENEREUM, LYMPHO-GRANULOMA INGUINALE, ORIENTAL SORE AND POST-OPERATIVE GANGRENE OF THE ABDOMINAL WALL

Syphilis

Syphilis is a general contagious disease which is contracted as a rule by the contacts of sexual intercourse. It is due to the *Treponema pallidum*. The primary local lesions which are often discharging sores may occur elsewhere than in the neighbourhood of the genitalia. They are extremely infectious. The illness may be acquired by contact with such sores. The organism may pass from the blood-stream of the mother through the placenta to the foetus, giving rise to congenital syphilis. Extra-genital syphilis would be more common than it is were it not that the treponema is a very delicate organism and cannot stand drying or cold. That is why contact must in general be actual, and infection by the mediation of cups, tumblers, pipes and instruments used in the mouth is rare.

Clinically the disease is divided into three stages: a primary stage lasting 4 to 8 weeks, a secondary stage extending up to 2 years and a tertiary stage which includes all manifestations which are met with after this period, however remote in time they may be.

After an incubation period of 21 to 28 days the primary lesion, called a chancre, appears. Typically this is a hard disc-like thickening of the skin which can be picked up between the fingers like a coin. The surface may be covered with intact epithelium, but there is more often a superficial ulceration with a slight, rather watery discharge which teems with treponemata. Frequently a secondary infection is added so that an angry red margin appears around the ulcer which now takes on a ragged sloughy base. The inguinal glands on both sides are enlarged though not to any great degree. They feel hard and shotty. They are separate from each other. The primary sore is found most frequently on the glans penis, particularly at the corona. Sometimes it is situated on the body of the penis or in the pubic

region at the root of this organ. In women chancres are usually on the labia majora or minora, or on the cervix uteri, very seldom on the wall of the vagina. They have not such distinctive characters as in men, are smaller and often pass unnoticed. Sometimes there is an associated infection with Ducrey's bacillus, the organism of venereal soft sores. Under these circumstances the chancre appears within a few days of infection, and its appearance is no longer characteristic, as indeed may be the case whenever there is any secondary infection. The added infection makes the inguinal glands fuse together and very likely break down with abscess formation (inguinal bubo). The fluid which exudes or is expressed from a chancre swarms with treponemata, which can be seen with ease under the microscope, thus establishing the diagnosis which it is essential to do at the earliest possible moment that the most efficient treatment may be given.

Extra-genital chancres are seen on the fingers particularly of doctors and nurses. They occur on the lips as the result of kissing, or the common use of infected cups or articles which are placed in the mouth. They are also seen on the tongue or tonsils and are sometimes transferred by dentists' instruments. On the fingers the sore usually takes the form of a very persistent paronychia. Primary sores on the lips or in the mouth are apt to lack the characteristic induration of those seen on the penis and they are accompanied by very pronounced glandular enlargement.

Even before the appearance of the chancre the treponemata have entered the blood-stream and the disease has become general. It is therefore quite hopeless to attempt to cut short the infection by excising the primary lesion.

In hereditary syphilis there is no primary chancre.

When the secondary stage comes on the patient begins to feel ill. He has fever, a rash and pains in various parts of the body, particularly the bones (osteocopic pains). When the fever has lasted about 48 hours a rash appears. The fever soon goes but the patient still suffers from malaise and very soon anaemia becomes evident. The lymphatic glands all over the body become palpable, hard and shotty. The enlargement of the epitrochlear glands and those in the posterior triangle of the neck is particularly important as these glands are not often enlarged as the result of local infections.

Various types of eruption occur. The commonest is a macular rash, but papular and pustular types are also frequently seen. The colour of these rashes is rather characteristic and is described as being like that of raw ham. When the rash recedes it leaves copper-coloured stains. Where two surfaces of the skin come into contact the papules are apt to broaden out into flat elevations called condylomata. These

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Neurosyphilis is a peculiar manifestation of the tertiary stage. It comes on sometimes as early as a year after the secondary stage. At other times it is delayed in onset for as many as thirty years. It may affect the membranes, the arteries or the neuroglial tissue. General paralysis of the insane and locomotor ataxia are due to it and neuritis or epilepsy may result. A sudden ptosis or an ocular palsy are very characteristic.

Hereditary Syphilis

Syphilitic women are very often sterile or abort in the third or fourth month. If the pregnancy goes to full term the child usually suffers from the disease. Curiously enough a healthy child may be born to a syphilitic mother and, even though she suckle it, escape infection. Sometimes also a woman may show no clinical manifestations of syphilis and yet give birth to a syphilitic child (Colles' law). Infection of the foetus takes place by the blood streaming through the placenta, usually during the fourth or fifth month of gestation. The child at birth appears healthy; it is only after 6 to 8 weeks that it begins to fail. It has snuffles with a purulent discharge from the nose. Then skin eruptions appear, macular or papular in type. There are mucous patches in the mouth at the corners of which fissures often form. When they heal they leave radiating scars as permanent stigmata of the disease in childhood (rhagades). The infant soon begins to go off its food and to waste. The skin is thrown into wrinkles. He looks like a shrivelled-up, wizened old man. Diarrhoea intensifies the wasting. The abdomen is enlarged, partly because of flatulence but also because there is diffuse gummatous infiltration of the liver and spleen which can be felt enlarged. A similar gummatous infiltration may affect other viscera such as the pancreas and lungs. A synovitis of the knee joints is common and acute epiphysitis is characteristic. This often affects the shoulder joint. It is an acute destructive process leading to separation of the epiphysis. The child ceases to use the limb so that the mother is apt to think that it is paralysed. There is swelling around the joint and tenderness but often apparently little pain. This is the syphilitic paralysis of the older writers. Localised thickening of the two parietal bones and the two halves of the frontal bone gives a curious shape to the head (the natiform skull), but sometimes instead of thickening there is a thinning of the parietal bones (craniotabes).

These children often die in infancy. If they do not, in a few years' time late tertiary lesions are seen. In the eyes there may be an iritis or what is very characteristic, an interstitial keratitis. A sclerosis of the internal ear causes deafness. A bilateral painless effusion into

lesions are seen especially around the anus and beneath pendulous breasts. Their surfaces are moist with exudation which contains myriads of treponemata. They are extremely infectious. On the mucous membranes of the mouth, larynx and pharynx similar papules form (mucous patches). They also are very infectious. On the tonsils and pharyngeal walls mucous patches may take the form of glistening streaks, the so-called snail-track ulcers. The laryngeal infection leads to hoarseness. The hair falls out, leading to alopecia, and a paronychia is quite common, and very puzzling if the underlying cause is not recognised. In addition to the osteocopic pains actual lumps appear on the bones. The subcutaneous bones, the tibiae, clavicles, skull, are chiefly affected. These elevations are called nodes. They may be hard or soft. Hard nodes are soft nodes in which ossification has taken place. Pains in the joints are due to a transient synovitis. This is not usually very severe. Only rarely is it acute.

A serious iritis may occur between the third and sixth months. Choroiditis and retinitis are seen only after many months.

In the late secondary stage a rather distinctive skin eruption is occasionally seen, called rupia or ecthyma. The lesions begin as papules which become vesicles, then pustules which dry up and become surmounted with conical crusts.

The tertiary stage of syphilis is characterised by the formation of syphilitic granulation tissue either in isolated areas or as a widespread infiltration of organs. The localised lesion is called a gumma. It is an extraordinary fact that a very long interval of many years may elapse between the end of the secondary stage and the appearance of tertiary lesions. All this time the treponemata must be alive, but where they lie dormant and why remains a mystery. The organism has been found in all tertiary lesions so that they must be regarded as infectious as all syphilitic manifestations, but the infectivity is not so great as in the primary and secondary stages. Gummata of the skin and subcutaneous tissue are seen typically in the legs below the knee, on the outer and upper part. They break down into ulcers which have borders circular in form or made up of segments of circles, with steep sides and a base covered with a slough which looks like a piece of wash-leather. When the ulcers heal they leave pale scars which are surrounded by a zone of brown pigmentation. Gummata or gummatous infiltration may occur in the bones, in the walls of bursae, in the synovial membrane of joints, in the testes, the liver, in muscles, and also in the tongue, in the lungs, in the walls of the heart and the arteries, and in the central nervous system.

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Day	Neoarsphenamine	Bismuth metal
1	0·45 gm.	0·32 gm.
8	0·45 "	0·32 "
15	0·60 "	0·32 "
22		0·32 "
29		0·32 "
36		0·32 "
43	0·75 gm.	0·32 "
50	0·90 "	0·32 "
57		0·32 "
64		0·32 "
71	0·90 gm.	
78	0·90 "	
85	0·90 "	
113	0·90 "	
120	0·90 "	

The neoarsphenamine is given intravenously, the bismuth as a o per cent suspension of bismuth salicylate in oil intramuscularly. he course may have to be prolonged if the Wassermann reaction emains positive or is slow in becoming negative. Arsphenamine is a powerful drug with toxic properties. It should be used with the greatest caution in debilitated individuals and in those suffering from disease of the kidneys or liver. Arsenical poisoning may cause a severe nephritis, an acute yellow atrophy of the liver, an exfoliative dermatitis or an encephalitis. In babies with congenital syphilis sulpharsphenamine, a sulphur derivative of the usual drug, is usually given. The baby receives three courses of 10 injections each of 0·05 gm. intramuscularly. At the same time the child should be given mercury. Hydrarg. c. creta gr. $\frac{1}{2}$-1 t.d.s. is a good way to administer it, or some ung. hydrarg. may be placed inside the binder and the patient receive it by inunction.

The primary sore in syphilis often does not require treatment. A dusting powder of equal parts of kaolin and calomel is usually sufficient. A sore secondarily infected is well treated by a wet

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the knee joints of a child should always arouse the suspicion of hereditary syphilis (Clutton's joints). Gummatous destruction of the vomer allows the bridge of the nose to fall in, another unfortunate sign of the disease which persists throughout life. Dactylitis in infants is more likely to be syphilitic than tuberculous. It is due to gummatous osteitis of the metacarpals or phalanges. Finally, the permanent teeth when they come through are deformed. They are peg-shaped, being narrower at the biting edge than at the base and this edge has a notch in it. The central upper incisors show this change best (Hutchinson's teeth).

The diagnosis of syphilis depends upon the recognition of the characteristic clinical features with the confirmation of the Wassermann or Kahn reactions. Although the *Treponema pallidum* has been found in all lesions of syphilis in every stage of the disease, the demonstration of its presence is only used in the diagnosis of the primary chancre. Here it is of inestimable value because the nature of the disease can be incontrovertibly established at a time when the serum reactions have not appeared, so that treatment can be instituted early and the ease with which cure can be brought about immensely enhanced. The Wassermann test depends upon the deviation of complement by the serum of a syphilitic patient so that haemolysis of sensitised corpuscles is prevented under test conditions. The Kahn test is a flocculation which is obtained when syphilitic serum is mixed with an antigen which contains lecithin bodies. Both these tests appear only after the infection has lasted ten to thirty days after the sore is first observed. They are both reliable in about 90 per cent of cases. A positive Wassermann test has been found in leprosy, sleeping sickness and in the height of the fever during an attack of malaria. It is also present in yaws. With these exceptions it is absolutely specific.

The Treatment of Syphilis.—It was Metchnikoff who discovered that if an area of skin were inoculated with treponemata and calomel ointment (calomel 1, lanolin 2) rubbed in within 24 hours, syphilis could usually be prevented. This fact is the basis of a prophylactic method. Once the primary sore has appeared it is of no use excising it for there is already a generalised blood infection. Yet there is need to begin treatment immediately, as the earlier in the disease it is carried out, the easier it is to bring about a cure. Always, therefore, an attempt should be made to establish the diagnosis by the demonstration of the treponemata in the primary sore before the Wassermann reaction has had time to appear. The organism is particularly susceptible to penicillin and certain compounds of the heavy metals, mercury, arsenic and bismuth. Mercury, the traditional remedy, has

softens; but the breaking down is due apparently to the toxins alone of the bacillus. Inoculation of the microbe from the first sore on to the surrounding skin may cause other sores to appear. A double infection with the *Spironema pallida* is not uncommon, so this should be thought of if the lesion becomes indurated.

The sore is best treated by bathing it with hydrogen peroxide followed by a dusting with calomel and zinc oxide powder in equal parts. A softened bubo should not be opened as an ulcer may result which will be very troublesome to heal. It is best to aspirate the gland and repeat the process if necessary. The infecting bacillus is eradicated by a course of sulphathiazol or sulphadiazine. Penicillin is inactive against the Ducrey infection.

Granuloma Venereum

This is a tropical venereal disease which, with few exceptions, is found only in negroes. The primary lesion is a papule and occurs on the genitals, or perhaps in the groin or pubic region. The cause, *Donovania granulomatosis*, is a bipolar staining inclusion body found in scrapings from the edge of the ulcer which soon results from the breaking down of the papule. The subcutaneous induration spreads widely; to the perineum, buttocks, scrotum and penis. The disease will last for years. It may cause stricture of the mouth of the urethra.

The best treatment is the administration of antimony as described under bilharzia (see page 711). A 1 per cent ointment of tartar emetic is useful as a local application to the ulcer. Good results have been obtained from M & B 693 (2-sulphanilylamino-pyridine).

Lymphogranuloma Inguinale

This also is a venereal disease very seldom seen in this country. It is due to a filtrable virus, and has an incubation period of 10 to 21 days. The primary lesion is a papule on the penis or vulva, or sometimes just within the urethra. The glands in the groin enlarge and become matted together. In women the inflammatory process spreads into the pelvis and is apt to cause a fibrous stricture of the rectum (see page 428). The diagnosis can be made by Frei's intradermal test, using fluid from an enlarged gland, or an emulsion of the brain of an infected mouse. Here again antimony is the best remedy (see under bilharzia, page 711).

Oriental Sore

Oriental sore, Delhi boil, Baghdad sore begins on the face, wrist r legs, as an itching red papule, which enlarges, softens and breaks

dressing composed of gauze soaked in lotio nigra. If the secondary infection reaches the inguinal glands and causes suppuration, the abscess will have to be opened.

In the case of the aged and those patients to whom the arsenicals might be dangerous to administer, that is those with hepatic or renal derangement, mercury should be given in place of arsphenamine. Hydrarg. c. creta in doses up to 3 or 4 gr. a day for one to two years with occasional intermissions is suitable. If the bowels are irritated, iron and opium are added—thus: Hydrarg. c. creta gr. 1, ferri sulphat. exsicc. gr. 1-2, pulv. ipecac. co. gr. 1. In the late secondary and the tertiary stages potassium iodide should be given in addition in doses of 5 to 15 gr. t.d.s., or the mercury and the iodide can be combined in a mixture such as: Liq. hydrarg. perchlor. dr. 1, pot. iodid. gr. 5, glycerin ♏. 10, aquam ad oz. 1, t.d.s.

Whenever mercury or bismuth are given great care should be taken to keep the mouth and teeth clean.

In the future it is very doubtful if, in the cure of syphilis, the above treatment will ever be used alone. Penicillin is the most powerful agent against the spironema known. It is effective in all stages of the disease. In neurosyphilis it is equally as good as any other drug and because of the absence of any other harmful side-effects it is particularly indicated; as it is also where there are cardiovascular manifestations. It is not yet known how permanent the penicillin cures will prove to be. There is no evidence pointing to their being less lasting than those obtained by the best remedies hitherto in use. At present in primary and secondary syphilis penicillin is used in combination with a short course of arsenic and bismuth. *In the tertiary stage penicillin and iodides are sufficient.* Quite probably penicillin will prove to be effective alone. The dose is large: 2,400,000 units in 60 intramuscular injections of 40,000 units each at three-hour intervals night and day. But to avoid such frequent injections the penicillin may be given in an oily base (4 per cent beeswax in ethyl oleate) which gives up the drug slowly. One daily injection of half a million units for six days suffices. When arsenic and bismuth are given in addition the course consists of 10 injections of 0·45 gm. neoarsphenamine with 0·2 gm. bismuth metal at four-day intervals.

Chancroid

Chancroid or soft sore is a venereal disease due to Ducrey's bacillus. There is an incubation period of about 5 days. The sore on the penis has sharp-cut edges and an angry red margin. It is not indurated. The inguinal glands enlarge to form a bubo which

softens; but the breaking down is due apparently to the toxins alone of the bacillus. Inoculation of the microbe from the first sore on to the surrounding skin may cause other sores to appear. A double infection with the *Spironema pallida* is not uncommon, so this should be thought of if the lesion becomes indurated.

The sore is best treated by bathing it with hydrogen peroxide followed by a dusting with calomel and zinc oxide powder in equal parts. A softened bubo should not be opened as an ulcer may result which will be very troublesome to heal. It is best to aspirate the gland and repeat the process if necessary. The infecting bacillus is eradicated by a course of sulphathiazol or sulphadiazine. Penicillin is inactive against the Ducrey infection.

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down into an ulcer. Several such lesions are frequently present. *The sores are very chronic, but they usually heal after 3 to 12 months.* The best local application is 2 per cent potassium antimony tartrate ointment. Intravenously the same drug is given as in bilharzia (see page 711).

Post-Operative Gangrene of the Abdominal Wall

This is a peculiar ulcerative condition which occurs rarely after an abdominal operation. There seems to be primary healing, but then the wound breaks down, forming an ulcer which spreads out into the surrounding area. It affects only the skin and subcutaneous tissue at first. The disease is extremely chronic and very difficult to check. After months it may have spread very extensively over the abdominal wall and on to the groin, where sometimes the femoral artery becomes invaded and the patient dies from a massive haemorrhage. Apparently the ulceration is due to a micro-aerophilic haemolytic streptococcus. Staphylococci, other streptococci and the *Bacillus coli* may also be present. The disease is sometimes seen apart from a laparotomy, for instance in the axilla.

The process can sometimes be stopped by destroying the advancing edge with the diathermy cautery, and searing the base. A 50 per cent suspension of zinc peroxide in 5 per cent sodium pyrophosphate has also been found very useful. Penicillin has cured when other methods have failed.

CHAPTER VI

HYDATID DISEASE

THIS disease is due to a small worm of only four segments called the *Taenia echinococcus*. It normally inhabits the intestine of the dog in hundreds or thousands. The adult worm has a head with four suckers, and a mouth surrounded by a ring of fifteen to twenty hooklets. The terminal segment containing the ova is passed in the faeces, and contaminates vegetables or other food, and thus passes into the alimentary canal of man; or a dog, by licking the hand or face of his master, may directly transfer the ova. Or perhaps more often the dog's paws or coat become contaminated with dried faecal dust, which is transferred to his master's hand. The disease is seen frequently in those countries such as Iceland and Australia, where men live in close association with dogs. Children are more susceptible to infection than adults. In the stomach the chitinous layer of the ovum disappears and an embryo, with three pairs of boring spines, is set free. These embryos enter into the radicles of the portal vein, and so reach the liver; but some pass through to the other parts of the body. Of all hydatid cysts 70 per cent are found in the liver, 10 per cent in the lungs and 20 per cent in the rest of the body, where they have been found almost everywhere. When the embryo comes to rest, it grows out into a cyst, which has an outer cuticular layer, and an inner parenchymatous layer. Surrounding all is a false capsule of fibrous tissue made by the host. On the inner surface of the wall of the cyst brood capsules develop, and these contain bunches of scolices which are really inverted heads of the worm. Very often daughter cysts form inside the mother cyst before the brood capsules develop (endogenous cyst formation). In some situations, as in bones, the daughter cysts form on the outer side of the mother cyst in the surrounding tissues (exogenous cyst formation). Sheep and pigs, not man, are the natural hosts of the cysts. The worm returns to the dog when that animal consumes infected tissues of one of these intermediate hosts.

Hydatid cysts contain a clear liquid of low specific gravity. When

down into an ulcer. Several such lesions are frequently present. The sores are very chronic, but they usually heal after 3 to 12 months. The best local application is 2 per cent potassium antimony tartrate ointment. Intravenously the same drug is given as in bilharzia (see page 711).

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CHAPTER VII

ACTINOMYCOSIS, GLANDERS, ANTHRAX AND MADURA FOOT

Actinomycosis

Actinomycosis is an infection by the streptothrix of actinomycosis, the identical organism which causes a similar infection in the ox. It has been thought to be a saprophyte which grows on grasses and that man can be infected by chewing grass. However, since the organism will not grow at normal temperatures it is not likely to exist as a saprophyte. Infection of man is more likely to be direct from contaminated dust, though it is quite possible that in some cases grass infected from cattle may be the vehicle by which it is transmitted. The organism gains entry into the body through the tonsil or through decayed teeth and sets up a chronic granulomatous change in the neighbourhood. This leads to great enlargement of the tissues surrounding the lower jaw and the neck. It spreads by continuity and not by the lymph-stream, so that the lymphatic glands are never enlarged at the same time. The result of its growth is the formation of a hard, very often dusky red, swelling, firmly attached to the jaw, frequently spreading down the neck where it causes a matting together of the structures here. Scattered through this mass are softened areas due to the breaking down of the diseased tissues which reach the surface and form sinuses. The sinuses exude a thin purulent fluid, containing tangled masses of the mycelium of the fungus, which look like little grains of sulphur. There is surprisingly little pain accompanying the disease but there are stiffness and restriction of movement of the jaw. When sinuses occur secondary infection is often added which leads to the formation of bone sequestra.

The disease, although it does not spread by the lymphatics, can enter the blood-stream and be carried on to other parts of the body. It also gains entry through the respiratory passages to the lungs, and by swallowing, may reach the caecum. In the thoracic type of the ase a portion of the lung is converted into a solid mass of hard

death of a cyst occurs, the contents become turbid and the whole cyst converted into a convoluted gelatinous mass in which calcification may take place. Infection and suppuration can also occur in a dead hydatid cyst.

In the diagnosis of hydatid disease an intradermal reaction with hydatid fluid, or a complement deviation test with the same liquid, is often of great help, because hydatids do not give distinctive symptoms by themselves. But a negative result does not exclude hydatid disease. The blood shows an eosinophilia.

Liver cysts may exist for years without being discovered. But leakage of cyst contents into a bile-duct causes recurrent biliary colic and jaundice. Should a liver cyst rupture into the peritoneal cavity multiple secondary cysts form all over the peritoneum. Not all the scolices develop; many wither and die. The prognosis is poor but cure may result after years of multiple operations.

In the lungs the shadow of a hydatid cyst is very like that of a secondary carcinoma or a dermoid. Many patients with the disease in the lungs cure themselves by coughing up the cysts.

Glanders (Malleus or Farcy)

This is a disease of horses, mules, asses, goats, dogs and cats. Cattle, mice and rats are immune. It is characterised by the formation of infective granulomata in the nares or under the skin, in both of which places abscesses form which break down leaving ulcers. The lungs can also be infected. The disease is due to a small bacillus, and is invariably fatal.

It begins with a remittent fever, headache, muscular weakness, pains in the back, so that the suspicion of typhoid arises, but in 12 to 14 days characteristic lesions appear in the nose as ulcers, or as lumps in the skin or in the muscles. When the tumours reach the surface and burst, a blood-stained fluid escapes containing numerous bacilli. The diagnosis is usually suspected when the subcutaneous nodules appear in the presence of the fever. It can be rendered certain by the discovery of the bacilli, and by the inoculation of a guinea-pig intraperitoneally with fluid from one of the abscesses. In a few days suppuration in the guinea-pig's testicle appears.

In the acute form death occurs in three weeks, but there is a chronic form which may go on for months with perhaps apparent cure but with an inevitable relapse. There is no effective treatment known. Nasal sprays render the patient more comfortable and the abscesses which occur must be opened, carbolised and drained.

Anthrax (Wool-Sorters' Disease)

This is a disease of cattle and horses. It does not attack the carnivora. It is very infectious and due to a short bacillus which is extremely resistant to heat and antiseptics in the sporing stage. It is transmitted by hides, hair, wool or the meat of infected animals. It may also be transmitted by milk, flies or dust.

There are two forms of anthrax, the external and the internal. External anthrax affects the skin, usually of the face but sometimes of the hand or fingers. Internal anthrax is due to the inhalation or ingestion of bacteria and gives rise to broncho-pneumonia or gastro-enteritis which are invariably fatal.

The characteristic lesion is called a malignant pustule though it is not really a pustule, as the contents of the vesicle are not pus but blood-stained fluid. There first appears a reddish papule which in time becomes surmounted by a vesicle. The red inflamed area spreads and is accompanied by a great deal of oedema. Soon the vesicle turns black owing to localised gangrene of the summit of the papule. In this stage there is a red elevation with a black centre,

granulation tissue, which spreads to the surface, frequently leads to the formation of an empyema and spreads right through the thoracic wall to the skin. A lump then appears on the thorax, very similar in character to the cervical disease, and with the typical sinuses.

In the abdomen the disease begins, as a rule, in the right iliac fossa. The appendix itself is rather frequently primarily affected. Here again a large hard mass is formed which invades all the tissues as it reaches them and ultimately comes to the surface and discharges through a number of sinuses. In the abdominal disease the fungus may enter the radicles of the portal vein and reach the liver, throughout which it spreads.

Actinomycosis is sometimes found in the most curious situations, as, for example, in the pyloric region of the stomach, causing obstruction, and in the small intestine, where it has the same effect.

The diagnosis of actinomycosis is made on the characteristics of the local lesion; the hardness, the invasion of surrounding tissues with the absence of definite edges seen in the case of neoplasms, and the existence of the sinuses from the exudation of which the fungus can be recovered. The thoracic disease is usually not diagnosed until it reaches the surface of the body, where it takes on its characteristic features. In the abdomen an ordinary suppurative appendicitis may show an indisposition to heal and a gradual formation of a hard mass around the drainage track. In such cases the diagnosis can often be made on microscopic examination.

The prognosis in the cervical form of the disease is fairly favourable. In the thoracic and abdominal forms it is bad though not hopeless, as a certain number of patients eventually recover. The cervical disease may last for years before it is detected and even then be amenable to treatment.

Surgically it is often necessary to curette the sinuses and provide drainage. Sequestra from the jaw must also be removed. Penicillin is the most certain remedy. It acts better against the disease when it is in the neck than when it is in the thorax or abdomen. It must be given in large doses (250,000 units daily) and for longer than the ordinary five-day course. Tinct. iodi. ℳ5-10 in milk three times a day is also useful. Larger doses are quite unnecessary. Good results have also been obtained by the use of X-rays, and from the injection of a vaccine made of broken-up mycelium.

Sulphadiazine or sulphathiazol have also been used with success. Probably, particularly in the abdominal form, it is best to give penicillin and sulphadiazine in combination.

CHAPTER VIII

DISEASES OF ARTERIES

Injuries to Arteries

Injuries to arteries occur in open wounds and also subcutaneously. The latter may occur in normal arteries but are more likely to happen when the arteries have become brittle with arteriosclerosis. Sometimes the ragged edge of a fractured bone will tear an artery. When an artery is divided cleanly across by some sharp instrument the bleeding is not necessarily very profuse as the internal and middle coats retract within the adventitia, curl up and soon lead to thrombosis which blocks the open end of the artery. This method of arrest occurs much more effectively when an artery is ruptured by a distracting force as when a limb is actually torn from the body. Under such circumstances even such larger arteries as the femoral and brachial may retract, the haemorrhage cease and the patient's life be saved. This stoppage of the haemorrhage is aided by the lowering of the blood-pressure which comes from the sudden loss of blood immediately after the artery is torn. If an artery is only divided in part of its circumference its natural elasticity will tend to make the wound gape. The haemorrhage will then continue until it reaches the danger point and perhaps is fatal. Subcutaneous rupture of a vessel leads to the formation of a large haematoma amongst the tissues which are torn by the force of the outpouring blood. The haematoma forms a fluctuating pulsating tumour. If the vessel is a large one, the pressure on the surrounding veins and lymphatics causes oedema of the distal part of the extremity and is very likely to obstruct the collateral circulation so that gangrene follows. If the pressure is not extreme enough to do that and the vessel becomes sealed off, the haematoma which is left sometimes becomes a cyst. It contains serum exuded from the

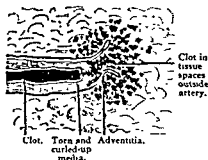


Diagram of a ruptured artery.

surrounded by vesicles. The neighbouring lymphatic glands are enlarged. General symptoms accompany the formation of the local lesion but they may be delayed for some days. They are a rise of temperature, perhaps a rigor, pains in the limbs, diarrhoea and delirium. The bacilli can be easily recovered from the fluid in the vesicle. Although the bacilli always get into the blood and produce a septicaemia, they are rather scanty and can be overlooked. When they are found rather easily the prognosis is always very bad.

A patient with anthrax is exceedingly infectious in the sense that the bacilli can be transmitted by dressings or discharges which have been in contact with him. Therefore, the greatest care should be taken to sterilise all his secretions, keep flies away from him, burn all dressings, his clothes and all bed linen when he has recovered. As soon as a diagnosis has been made, Sclavo's serum should be administered. This is obtained by immunising a donkey. It is quite innocuous and can be given in large quantities, either intravenously or subcutaneously. 40 c.c. should be given as a primary dose and repeated in 4 hours. After this 20 c.c. should be given every 4 hours until the subsidence of the symptoms.

Local excision of the pustule is only to be recommended in the very early stages because the infection invariably enters the bloodstream. Fulguration of the papule is better than knife removal. A number of cases have been treated successfully with neosalvarsan given in doses of 0·06 gm. on two successive days.

Madura Foot

This a disease met with in tropical countries due to the *Streptothrix madurae*. It begins as an induration in the subcutaneous tissue of the lower leg in the neighbourhood of the ankle. It soon breaks down with the formation of sinuses, in the discharge from which granules composed of masses of mycelium can be detected. The infective process spreads like actinomycosis, invading the bones and joints, and destroying the function of the foot, so that no treatment is of any use but amputation.

segment of the artery into a fibrous cord. In the case of a wound of the neck where it is not possible to use a tourniquet, haemorrhage must be stopped by pressure with the finger, and whilst pressure is maintained the wound must be enlarged, a dissection made of the artery proximal to the wound and the artery grasped in pressure forceps. Sometimes it is possible to seize the artery in the bottom of the wound with forceps by just removing the finger for a moment, when, if the patient is suffering severely from shock, and the artery is contracted, the spurt of blood will not be very vigorous. The loss of blood from haemorrhage must be treated by transfusion when necessary and remedies against shock employed.

It is sometimes possible to suture wounds of arteries but a good result can only be obtained if the wound remains absolutely aseptic. It is easier to suture a longitudinal wound in an artery than a transverse wound where much retraction causes wide separation. The secret of arterial suture is the use of very fine silk which has been boiled in paraffin so as to remove its clot-exciting properties and the eversion of the arterial wall so that endothelium comes against endothelium, just the same principle as suturing intestine together and inverting the ends, so that again endothelium may rest against endothelium.

The suture of arteries does not play a very prominent part in surgery because the conditions are so seldom favourable for its performance and failure so frequently occurs because thrombosis takes place at the sutured spot. When possible, however, suture of those arteries which it is dangerous to tie should always be practised. Thrombosis at the site of suture is delayed or prevented by the giving of heparin or heparin followed by dicumarol (see page 76). Unfortunately an aneurysm nearly always develops at the operation site within 3 years of a successful suture. Therefore, in general, ligature is better than arterial suture.


The suture of an artery. The intima must be everted.

After ligature of the abdominal aorta death inevitably occurs. Ligature of the common carotid artery leads to necrosis of the brain in one-third of the cases, so that the patient suffers from a hemiplegia on the opposite side of the body. If it be the left artery that is tied, he suffers from aphasia as well. Ligature of the axillary artery or the popliteal artery leads to gangrene in 15 per cent of cases; ligature of the subclavian or brachial artery in about 5 per cent of cases; ligature of the common iliac is followed by gangrene in 50 per cent; the common femoral in 25 per cent; the superficial femoral or external iliac arteries when ligated are followed by gangrene in about 12 per cent of cases.

clot which lines the wall of the cavity and which gives rise to an inflammatory reaction exciting thereby the formation of a fibrous tissue capsule.

In the treatment of open wounds of arteries, the first thing is to bring about the immediate arrest of the haemorrhage; the next thing is to combat shock (see page 30).

The immediate arrest of haemorrhage can be brought about by pressure upon the actual bleeding point. When the first flow of blood has been stopped in this way, the main vessel above should be compressed if this is possible anatomically. In the case of the limbs a tourniquet is used. Several *precautions must be taken in applying* the ordinary circular rubber tourniquet. It should never be in direct contact with the skin. Interposed beneath it there should be a folded cloth. It should not be left on a limb for long periods or there is some danger of gangrene following. In the case of the arm it is quite possible to apply the tourniquet so tightly that the large nerves are damaged by compression against the humerus with *resulting paralysis. For most purposes, when haemostasis of the* upper limb is desired, as in planned operations, a blood-pressure apparatus is the safest constrictor to use (see page 24). When the circulation has been controlled by a tourniquet the wound can be attended to. If it is an accidental wound it should be rendered as aseptic as possible. Then the ends of the divided artery are sought for and tied. In the case of the larger arteries the ligature should *not be tied too tightly, for, if it is, the whole of the artery wall within* its grasp may necrose and the vessel give way before there is time for the organisation of the clot. This does not happen if the vessel is divided between two ligatures and the cut ends allowed to retract, thus eliminating all tension on the vessel wall. The knot most useful in ligating arteries is the so-called surgical knot, which is a reef knot in which a single turn succeeds a double turn. Drainage is usually required in accidental wounds.

When an artery is ligated, the object of the ligature is not only to obliterate the lumen of the artery but to damage the internal and *middle coats of the artery in order to hasten* repair. Ligatures should be pulled sufficiently tightly to effect this. Coagulation of the blood *within the artery begins from this* damaged part of the arterial wall and spreads upwards along the artery until a branch is reached where it stops. *From the torn part of the media and intima,* and from the undamaged intima irritated by the presence of the clot, granulation tissue is formed which ultimately changes the affected

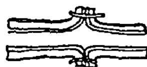


Diagram to show the clot extending up to the first patent-branch.

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When one of the large arteries is to be tied it is sometimes recommended that the accompanying vein should be ligated at the same time, because it is said that the nutrition of the tissues is helped by this damming-back of the blood. Some surgeons recommend that when the common carotid is tied the jugular vein should be tied also, but declare that vein ligation in the case of the large vessels of the extremities does not influence the result favourably. There is a good deal of conflicting evidence on this point.

Acute Arteritis

is of interest surgically when it is due to acute septic infection spreading to the artery from the surrounding tissues. If the arterial wall becomes acutely inflamed and infiltrated with leucocytes, it may disintegrate and cause a secondary haemorrhage. This is particularly likely to occur if, in a septic wound, a drainage tube is allowed to press on the wall of an artery.

Chronic Arteritis

is of interest surgically in connection with infections by the *Spironema pallida* and the *Bacillus tuberculosis*, in both of which cases a narrowing of the vessels, due to a thickening of the intima, results in the caseous necrosis of tuberculosis, or the gummatous necrosis of syphilis.

Arteriosclerosis of the arteries may lead to gangrene and particularly when it is associated with atheroma, makes the vessel wall more vulnerable to injury and so to thrombosis, which itself may lead to gangrene.

Aneurysms

An aneurysm is an abnormal dilatation of an artery. Aneurysms are classified as follows:

1. True Aneurysms: (a) Fusiform.
   (b) Saccular: (Spontaneous).
   (Traumatic).
2. False Aneurysms.
3. Traumatic Diffuse Aneurysms.
4. Dissecting Aneurysms.
5. Arteriovenous Aneurysms.
6. Cirsoid Aneurysms.

True Aneurysms

A fusiform aneurysm is one in which the whole of the arterial wall gives way to pressure, forming a spindle-shaped swelling. In

these aneurysms the wall is formed by all the coats of the artery though they are stretched and thin.

In a saccular aneurysm a portion of the circumference of the wall alone gives way before the pressure, so that a little bag on the side of the artery results. The wall of this sac is composed of adventitia, the media and intima passing only for a very short distance beyond the opening into the main vessel. Such saccular aneurysms are sometimes the result of injuries to the arterial wall which destroy the strength of the middle coat, or even rupture the walls of the artery, allowing the blood to escape into the surrounding parts, where it is confined by an adventitious wall of fibrous tissue.

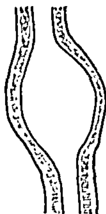


Diagram to show how the adventitia, media and intima all take part in the wall of a fusiform aneurysm.

In spontaneous saccular aneurysms and fusiform aneurysms there is some disease of the arterial wall which, in very many cases, is the chronic arteritis due to syphilis. However, it must be recognised that there is an element of injury which comes into play in a number of cases of aneurysm, particularly those of the popliteal artery, which perhaps is subjected to pressure by the heads of the gastrocnemius muscle.

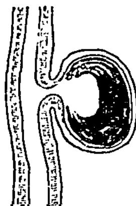


Diagram to show that the wall of a saccular aneurysm is found by adventitia alone, except in the neighbourhood of the entrance. Laminated clot in sac.

No aneurysm after its formation remains stationary. The fusiform variety ultimately will have a saccular aneurysm develop in its wall. As an aneurysm grows it causes considerable destruction of the tissues round it. It may, in fact, actually erode bone. An aneurysm in the superior mediastinum may penetrate the sternum, cause pressure necrosis by cutting off the blood-supply of the overlying skin, and eventually rupture on to the surface: or an aneurysm of the aorta may cause the bodies of the vertebrae to become eroded, which gives the spinal column a characteristic appearance, for the intervertebral cartilages withstand pressure by an aneurysm better than does the intervening bone. Sometimes an aneurysm undergoes spontaneous cure owing to the formation of clot within its cavity, a clot which ultimately is changed into connective tissue. Another result from aneurysm is suppuration of the surrounding tissues, which are always inflamed and matted together in a way which makes an

operation in the neighbourhood of the aneurysm extremely difficult. If this tissue suppurates an abscess may form which, rupturing into the aneurysm and on to the surface, causes death from haemorrhage or from pyaemia. The subcutaneous rupture of an aneurysm leads to the formation of a large pulsating haematoma and nearly always to gangrene from pressure upon the neighbouring veins.

Clinically, an aneurysm forms a swelling in the course of an artery which exhibits expansile pulsation. If the main vessel above the aneurysm be compressed the tumour shrinks in size and the pulsation diminishes or disappears. The strength of the pulse beyond an aneurysm is less than on the unaffected side. On auscultation there is a hissing sound heard with each heart-beat, due to the eddies which are set up in the expanded arterial cavity. Difficulties in diagnosis sometimes arise when inflammation occurs in the tissues round the artery, and if there has been a subcutaneous rupture, the resulting condition simulates very strongly an abscess. This is particularly the case in the popliteal space where the pulsation may not be so evident because of the dense and thick popliteal fascia.



Two vertebra eroded by the pressure of an aneurysm.

As aneurysms increase in size they are apt to produce symptoms by pressure upon the veins and nerves in their neighbourhood. Pressure upon veins will produce oedema of peripheral areas and pressure upon nerves will produce paralyses, paresthesiae and neuralgic pains.

Spontaneous aneurysms are not very common nowadays because of the more effective treatment of syphilis.

The Treatment of Aneurysms.—Unfortunately the commonest aneurysms which occur, those in the aorta, are not very amenable to treatment. All that can be done in such cases is to limit the strain imposed upon the arterial wall by forbidding all occupations and pursuits which give rise to increased blood-pressure; that is, very little exercise should be taken, worry and anxiety should be avoided, tobacco and alcohol forbidden. Potassium iodide internally has long been thought to have a favourable effect, which is brought about partly by its lowering the blood-pressure and partly by its influence on the syphilitic process.

A method of treatment which has been used and which has sometimes met with success is the partial obliteration of the aneurysmal sac by the excitation of thrombosis by the introduction of wire through a cannula thrust into it. As a rule, however, such operations are not indicated.

In the limbs the following methods of dealing with aneurysms have been used:

The Operation of Antyllus.—Antyllus recommended that both ends of the artery entering into the sac should be ligated, the artery opened and the clot turned out.

Syme's Operation was very similar. He opened the sac, plugged the bleeding openings with his fingers, tied the two vessels and packed the cavity with plugging. An unnecessary amount of blood was lost in this procedure.

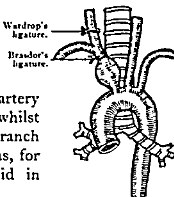
Anel's Operation is the ligation of the artery immediately above the sac. The difficulties about this operation are that the tissues round the sac are extremely difficult to dissect, whilst the artery here is likely to have damaged walls and the ligature not be a success. Another objection to Anel's operation is that the collateral circulation may be so free that the blood can get into the sac from some branch opening into it.

Hunter's ligature.

Anel's ligature.

Aneurysm of the popliteal artery showing the anastomatic circulation and the points of application of the ligature by Anel and Hunter.

Hunter's Operation is a proximal ligature at some distance from the sac. It was devised by Hunter for the treatment of popliteal aneurysm and consists in ligating the superficial femoral artery in Hunter's canal. The advantage of tying the artery in this situation is that a normal vessel with unaltered anatomical surroundings is operated upon.



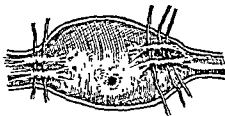
Aneurysm of the innominate showing the application of the Brasdor and Wardrop ligatures.

Brasdor's Operation is ligation of the artery immediately beyond the aneurysmal sac, whilst *Wardrop's Operation* is the ligation of one branch of the main artery after it has left the sac, as, for instance, the tying of the common carotid in aneurysm of the innominate artery.

When a large artery has to be tied for the cure of an aneurysm the possibility of gangrene has to be considered (see page 63). Gangrene of the brain and the subsequent hemiplegia with, perhaps, asphasia is the most serious of all complications, so that if the innominate artery or the common carotid or the internal carotid must

be tied, special precautions should be taken to avoid if possible this dreadful complication.

One way to do this is to endeavour to open up the collateral circulation by digital pressure on the artery for two or three hours every day in the week preceding the operation. This procedure can be maintained by relays of assistants. Another method is to operate and apply either a malleable metal band which is only partly compressed, or to tie a temporary ligature round the artery which will just obliterate its lumen, but will not damage the walls, and can be removed should signs of hemiplegia come on. An ingenious way of estimating the safety of ligature of the internal carotid has recently been reported. An electro-encephalogram is taken from the patient's brain during the application of a temporary ligature. If there is no change in the tracing it is assumed that ligature will not cause serious cerebral anaemia. It has proved a reliable method.



Matas' aneurysmorrhaphy. The openings of the main trunk are obliterated by pleating the walls of the aneurysm from within the sac. The openings of branches are closed in the same manner. The whole cavity is sometimes obliterated by infolding the sac in successive layers.

Whenever a large artery of the extremity has been tied the limb should be elevated, protected with wool and kept as warm as possible.

Matas' Operation for aneurysm is called endoaneurysmorrhaphy. It is a direct attack on the aneurysmal sac. Under tourniquet haemostasis the sac is exposed and opened. Two procedures can now be carried out. Obliterative endoaneurysmorrhaphy is the obliteration of all the vessels opening into the sac by suturing from within the sac, which is then plicated up by successive layers of sutures until it is converted into a solid mass of folded tissue.

Reconstructive endoaneurysmorrhaphy is an attempt to sew the arterial wall and the aneurysm together so that a channel is left between the entering and emerging vessels which is of approximately the normal size. Reconstructive endoaneurysmorrhaphy is very seldom successful.

False Aneurysms are aneurysms which result from the giving way of an artery and the formation of a sac outside formed by the surrounding tissues. The treatment is the exposure of the artery and the ligation of the two ends connected with the sac.

A *Traumatic Diffuse Aneurysm* is simply the pulsating haematoma which results from an injury to an artery when the blood is confined in a space produced by the tearing apart of neighbouring tissues. It must be opened and the wounded vessel ligated.

A *Dissecting Aneurysm* is a form of aneurysm which occurs only in the abdominal aorta. It is due to atheroma of the vessel and the giving-way of the intima so that the blood is forced between the layers of the media and very often enters the lumen of the artery again. There is no treatment. The condition is always fatal.

Arteriovenous Aneurysms

An arteriovenous aneurysm is an aneurysm in which there is a direct communication between an artery and a vein. The vast majority of arteriovenous aneurysms are due to injury. Rarely there are congenital openings between the arteries and the veins.

Traumatic Arteriovenous Aneurysms

The injuries are usually due to a stab or gunshot wound. The walls of both vessels may be penetrated but usually the artery is first damaged and then becomes glued to the accompanying vein, ultimately opening into it. When the connection is direct we have aneurysmal varix. In other cases a false aneurysm forms on the wall of the artery which ultimately opens into the vein so that there is a communicating sac between the two vessels. This is called a varicose aneurysm.


Varicose aneurysm.


Aneurysmal varix.

Another example of arteriovenous aneurysm is that due to a fracture of the base of the skull when the internal carotid artery opens into the cavernous sinus. In the case of the extremities the arteriovenous aneurysm causes the veins beyond the site of the injury to be very much dilated and to pulsate. The whole distal part of the limb is swollen and dusky in colour. The pulse beyond the aneurysm is smaller than on the normal side. When the internal carotid communicates with the cavernous sinus there are oedema of the conjunctivae, protusion of the eyeball, pulsation of the orbital tissues, suffused conjunctivae and dilatation of the veins around the orbit. The patient is also worried by a loud rushing noise in his head which accompanies each heart-beat. This sound can be heard by an observer with the aid of a stethoscope if he places it over the orbit. Indeed it is characteristic of all arteriovenous aneurysms that, over the communication, a continuous rushing sound can be heard, which is increased in intensity with every systole.

A rare form of arteriovenous aneurysm has occasionally occurred between the carotid and the internal jugular vein following an operation on the tonsils.

When there is a communication between the vein and the artery the blood is short-circuited by the opening and so does not circulate properly through the limb. Peripheral resistance is so much lowered that the heart has to beat more strongly and, as a rule, more quickly. This overwork of the heart muscle ultimately leads to myocardial degeneration, so that an arteriovenous aneurysm must be regarded as a very serious and, indeed, a distantly fatal condition. It is therefore essential that such *patients should be operated upon in order to* preserve their lives. Such operations should not be performed within three months of the injury unless the surgeon's hand is forced by steady increase in the size of the aneurysm and severe pain. The delay allows the anastomotic circulation to open up so that the danger of gangrene from ligation of a main artery is very greatly lessened.

The treatment of an arteriovenous aneurysm in an extremity is *the separation of the artery and vein from each other and the double* ligation of the artery above and below the abnormal opening. The opening in the vein is sutured or the vein may be tied. Under exceptional circumstances the two vessels are separated and the openings in both of them sutured. The essential step is to prevent the short-circuit of blood through the new-formed channel.

When pulsating exophthalmos is due to a communication between *the internal carotid and the cavernous sinus the surest operation* is ligation of the internal carotid artery. It is sometimes difficult to know which internal carotid to tie, as when the condition has once been established blood rushes from one cavernous sinus across to the other. By compressing the carotids in the neck it is very easy to determine which one is causing the trouble by the diminution of the noises which the patient hears when the vessel is obstructed. There does not seem to be the same risk in ligating the internal carotid for this condition as for aneurysm outside the skull, for if the condition *has lasted a long time the collateral circulation is very likely to have* established itself. A less certain procedure, but one accompanied by a less risk of cerebral damage, is the *simultaneous ligation of the* common and external carotid arteries. In America this condition has been treated by ligation of the anterior cerebral artery after opening the skull and lifting the frontal lobes of the brain. Injection of a sclerosing fluid into the angular vein has also been recommended, and carried out successfully.

Congenital Arteriovenous Aneurysm

This is a rare condition and presents itself sometimes as an enlarged blue extremity in which the veins are engorged with blood and pulsating. In such cases the communication is some distance up the limb. There is also a much more limited lesion which affects the smaller arteries and veins of the hand and fingers so that soft pulsating tumours are formed and perhaps one or two fingers are very much enlarged. In these cases there are multiple communications between arteries and veins. Patients usually present themselves before the age of twenty. The tumours not only pulsate but are compressible to some degree and have a bruit synchronous with the heart-beat. Congenital aneurysms have the same bad effect upon the heart as other arteriovenous aneurysms. That oxygenation is being carried on inefficiently can be demonstrated by estimating the oxygen in the venous blood, which on the affected side may be as much as 20 per cent by volume, whereas on the normal side it is only 15 per cent. Also the oxygen saturation of the blood in the veins is 95 per cent on the diseased side in contrast with 60 to 70 per cent on the normal side. The blood from the veins on the affected side is actually redder in colour than that on the other.

The difficulty in treating these patients is to know exactly where the abnormal anastomoses are. They are likely to be multiple and perhaps are some distance up the limb. In order to determine the situation of these communications arteriography is performed. This is the injection into the brachial artery of 10 c.cm. of thorotrast and the immediate skiagraphy of the part. The abnormal openings are clearly demonstrated. Usually it is necessary to amputate a finger or a part of the hand. Only in a few cases it is possible to separate the vessels higher up and get rid of the abnormal anastomoses.

Cirsoid Aneurysms

A cirsoid aneurysm is really a variety of congenital arteriovenous aneurysm. It occurs most commonly in the scalp in the temporal region where there is a soft compressible pulsating mass made up of many tortuous branches of the temporal artery. When these tumours are dissected it is found that there are a number of communications between the arteries and veins.

It is an extremely difficult condition to treat. Ligation of the supplying vessels is very often ineffective and the injection of sclerosing fluids usually fails. If an attempt is made to excise the

aneurysm there may be furious haemorrhage. The best method would seem to be to turn down a flap of the scalp, leaving the network of vessels on its deep surface, the circulation being partly controlled by a tourniquet round the skull. This tourniquet will not control the communications which go through the skull and these must be dealt with either by ligating or by the use of Horseley's wax. The flap is then sewn back, a piece of gauze being interposed between it and the skull. After four days the scalp is turned down again, when it will be found that the vessels have thrombosed and the whole mass can be dissected away.

Angiomata (naevi)

If we regard angiomata as true tumours and assume them to be the response to a virus attack upon endothelium, we should expect them to be masses of proliferating capillaries or endothelial-lined spaces, which indeed they are. Only rarely do we find new arterioles present. But there may be some interstitial formation of fat or fibrous tissue (naevo-lipoma, naevo-fibroma) and lymphatic spaces may share in the enlargement. Angiomata are innocent tumours. A metastasising angioma is a curiosity. The majority of them are present at birth or appear during the first year, and half of them are on the head or neck. Occasionally a naevus may disappear early in life, but usually it continues to grow though at a diminishing rate.

Capillary angiomata occur in the skin and form bright-red flat-topped elevations. Port-wine stains are capillary naevi in a narrow superficial zone of the derma, whilst spider naevi are enlarged stellate capillaries in the same situation.

Cavernous angiomata are found in the subcutaneous tissue forming soft bluish compressible elevations. They are often associated with the capillary form when they are red-topped. Cavernous angiomata are also found in muscles, the intestine, the liver and in bones. A characteristic site of this last rare tumour is a lumbar vertebra which, in a skiagram, takes on a striated appearance. The spaces in cavernous angiomata tend to enlarge and coalesce by the disappearance of contiguous walls.

In like manner communications may be made with neighbouring normal vessels so that the angioma becomes a pulsating tumour. When extensive angiomatous formation takes place in a limb, with perhaps such arteriovenous communications, hypertrophy follows, bringing about the condition already referred to above (page 71). This condition is sometimes called a diffuse systemic angioma.

Hypertrophic or angioblastic angion

met with as solid, elevated, purplish-red lesions of the surface, which are not compressible, because the spaces have been obliterated by the proliferation of the endothelium.

Hereditary haemorrhagic telangiectasia is a rare disease in which tiny naevi form in the mucous membrane of the nose, mouth or intestine, and lead to severe haemorrhages. It runs in families and does not usually come on until after thirty.

The best treatment for all naevi if possible is excision. This should not be done during the first year of life unless the growths are enlarging, as sometimes spontaneous disappearance occurs at this age. When excision is impractible or would prove disfiguring other methods are used. The red cutaneous naevus can be cured by the application of carbon dioxide snow for 20 to 30 seconds. Subcutaneous cavernous naevi cannot be cured in this way. They can be electrolysed or sclerosed by injection, or treated by ignipuncture or radiated. For electrolysis one electrode should be a flat moist plate attached to the patient's body; the other a needle attached to the negative pole of the battery. This needle is inserted into the tumour and a constant current of 20 to 80 milliamperes passed until coagulation takes place around it. The process is repeated from a number of punctures. Ignipuncture is carried out by thrusting a red-hot cautery point into the substance of the tumour from a number of places. Surprisingly little permanent scarring remains from this procedure. A diathermy needle is better for this purpose. The best sclerosing agent is 5 per cent sodium morrhuate (½ to 3 c.c.). The injection should be repeated at fortnightly intervals. A good method for large cavernous angiomata is the injection of boiling water (3 to 5 c.c.). If care be taken, there will be no sloughing of the overlying skin. When sclerosing methods fail, radon seeds may bring about recession, or, if the naevus is small, an external radium application may be used.

Lymphangiomata

A lymphangioma is usually of the cavernous type and subcutaneous. It forms a flat elevation. The overlying skin is normal in appearance or has brownish vesico-papules or papillomatous projections on it. Lymphangiomata are not so compressible as haemangiomata. The endothelial lining of the cavernous spaces is more likely to be many-layered, and fat or fibrous tissue to be present.

In the neck large cysts may form (cystic hygroma), perhaps developed from embryonic lymphatic sacs which originate in this region.

There also occurs a diffuse systemic type of lymphangioma which affects a whole extremity. Growth is slow over many years, but the whole limb appears hypertrophied. The skin is normal or has papules on it. The angioma is of the cavernous variety.

As in the case of haemangiomata, excision is the most satisfactory treatment. Sodium morrhuate injections are not so effective but should be tried. Lymphangiomata are radio-resistant.

CHAPTER IX

DISEASES OF VEINS

Phlebitis

Inflammation of veins is classified as plastic or infective. Plastic phlebitis is seen as the result of injury, particularly with varicose veins of the leg or, rarely, in some diseases associated with great cardiac weakness where, probably, many factors come into play. In plastic phlebitis the wall of the vein becomes inflamed and leads to thrombosis. The inflammation spreads to the surrounding tissues with the formation of a column of tissue reaction along the course of the vein. The results of this may be the resolution and recanalisation of the lumen of the vein, or complete obliteration with the formation of a fibrous cord.

In the septic variety of phlebitis there is a direct extension of a pyogenic inflammatory process to the wall of the vein, causing a thrombosis. It is usually followed by a suppurative disintegration of the clot, portions of which become detached into the circulation and give rise to pyaemia.

Post-operative thrombo-phlebitis is a fairly common complication of abdominal operations, particularly those which involve the pelvic organs. It is said that it occurs in 2 per cent of all cases. Attention is usually called to the condition when the process has spread to the femoral or internal saphenous veins, but it begins unobtrusively in the veins of the calf. Probably there is an infective element in the process, because thrombo-phlebitis is more common after septic operations than after clean procedures. It is thought that the greater incidence on the left side may be due to the pressure of the right common iliac artery or the sigmoid flexure of the colon upon the left iliac vein which causes some obstruction to the flow of blood. Certainly a sluggish venous stream disposes to coagulation, and it is quite possible that some hindrance may be caused by the acute flexion of the hip joints in the Fowler position, or pressure upon the popliteal or calf veins by the knee-support. Accessory factors are anaemia and weak cardiac action.

At the beginning the process is a *non-obstructive thrombosis*, which may extend upwards from the calf to the femoral and iliac veins. The signs are rather insignificant but this is the dangerous stage.

If the obstruction becomes complete, an active inflammatory process occurs. Pain and acute tenderness occur along the femoral or internal saphenous vein. There are a rise of temperature and oedema with often some duskiness of the leg. Often there is a peripheral arterial spasm. The danger of embolism when there is a pronounced inflammatory reaction is slight. The condition is best treated by hot wet boric dressings locally, papaverine in half-grain doses for pain every 4 hours if necessary, raising the limb and injection of the lumbar sympathetic. This last procedure abolishes peripheral arterial spasm; the pain and swelling go and the fever subsides.

It is in the quiet non-obstructive stage that the danger of embolism is present. Indeed, a pulmonary embolus may be the first sign that calls attention to the condition. There may have been a little stiffness of the calf muscles. Dorsi-flexion of the ankle with the knee extended leads to pain in the calf. Usually there is a rise of temperature. The separation of a small fragment of clot leads to substernal or pleuritic pain, cough, faintness or breathlessness. When such signs occur *measures to prevent further embolism are urgently needed*. By some surgeons ligation of the femoral vein is recommended, or if the clot has extended as far up as this, ligature of the common iliac vein. It is not advisable to tie the common femoral vein as this may cause serious swelling of the leg. The results of the administration of heparin or dicumarol offer a more attractive measure of dealing with this frequently tragic emergency. It seems clear that embolism occurs only when a thrombus is of very recent origin. Therefore it will not happen if the sudden extension of a known thrombophlebitis be prevented. *Dicumarol* (300 mg.) is given during the first 24 hours, 200 mg. on the second day and 50 to 200 mg. on successive days. Always must the dosage be controlled by the prothrombin time. If after 500 mg. have been given this time is up to twice its initial value, no more of the drug is given. Care should be taken with a rapidly rising prothrombin time as the effect lags behind the time of dosage for 24 to 48 hours. For this reason during the first 24 hours, heparin 1 to 2 c.c. (containing 1000 Toronto units in 1 c.c.) in 100 c.c. saline per hour may be given. Do not let the prothrombin time rise above 30 seconds, and should haemorrhage occur give a dose of vitamin K (64 mg. menadione bisulphate) intravenously.

Since a sluggish venous circulation is a predisposing cause of

post-operative thrombo-phlebitis, some surgeons recommend early exercises for the legs to prevent its onset, and even get their patients out of bed on the second or third post-operative day. The risk of thrombosis is not a sufficient justification for this latter precaution.

Should, from a large pulmonary embolus, death appear to be inevitable, the clot in the main branches of the pulmonary artery can be removed by Trendelenburg's operation. The chest is opened close to the left of the sternum by dividing the 2nd and 3rd costal cartilages. The pulmonary artery is approached transpleurally, and the pericardium opened. A rubber tube is passed around the origins of the aorta and pulmonary artery through the sinus pericardii. This controls the circulation whilst the pulmonary artery is opened and clot removed from one or both of its branches. The circulation should not be interrupted for longer than 45 seconds. A number of successful operations have been reported, but the difficulty is to select the particular patient needing operation and to be on the spot in readiness. For a number of patients apparently mortally ill recover. Others live for about half an hour before succumbing. Usually the surgeon waits until death seems certainly imminent before he begins his operation.

Septic Thrombo-Phlebitis is fortunately a much less common condition. It sometimes occurs as a complication of appendicitis affecting the ileocolic vein and giving rise to portal pyaemia. It occurs in association with carbuncles of the face when the angular branch of the facial vein is affected. The inflammatory process may spread back through the orbit and cause thrombosis of the cavernous sinus, a usually fatal complication. Infection of the mastoid antrum may extend backwards through the bone to the lateral sinus, which becomes thrombosed. The clot may spread right down the jugular vein into the neck. Lateral sinus thrombosis has a high mortality but is not always fatal. In the limbs sometimes a septic thrombosis occurs, when an abscess forms in the neighbourhood of a vein. The gravity of septic thrombo-phlebitis resides in the great tendency to cause pyaemia.

Treatment is directed to prevent this serious complication. If one of the superficial veins in the leg is affected, the proper treatment is to tie the vein above and below the diseased area and to excise the inflamed portion. When it is thought that the lateral sinus is thrombosed the mastoid process should be gouged away until the vein is exposed in order to confirm the diagnosis. The internal jugular vein in the neck is then ligated in an attempt to prevent a piece of disintegrated clot flowing into the circulation. The wound in the

skull is then returned to, the lateral sinus opened widely. Should a free flow of blood occur, it can easily be stanched by gauze plugging. It is not necessary deliberately to turn out the clot until this happens.

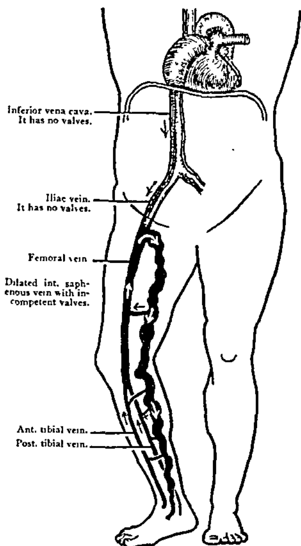


Diagram to show the reversal of the direction of the blood flow in the dilated varicose saphenous vein, and the column of blood uninterrupted by valves from the right auricle downwards.

The difficulty in the case of *thrombosis of the lateral* sinus is that the process may spread along the petrosal sinus and reach the cavernous sinus. In carbuncles of the face an attempt is sometimes made to ward off thrombosis of the cavernous sinus by tying the angular vein. The difficulty is to know when it is necessary to carry out the operation. Not all carbuncles of the face *lead to facial vein thrombosis* and fewer to cavernous sinus thrombosis, so that it is not easy to assess the value of the operation of tying the angular vein. Thrombosis of the cavernous sinus was invariably fatal until the discovery and use of penicillin. Now cures are *being reported* (see also pages 35, 40).

There is no treatment for portal pyaemia, which results in multiple abscesses of the liver and death, unless penicillin can bring about a cure.

Varicose Veins

Varicose veins are dilatations of the veins, usually the superficial veins of the lower limbs, though very rarely the deeper veins are affected. There is not only a dilatation of the veins but they become increased in length so that they are thrown into bends and coils. The walls of varicose veins become thinned and show fibrosis. The muscle tissue disappears. Owing to dilatation of the veins the valves become

incompetent. As there are no valves in veins within the abdomen, the result of this may be that there is an unbroken column of blood from the heart to the peripheral end of the internal saphenous vein. The loss of the support of competent valves throws a great strain on the venous walls and leads to further dilatation. If, under these circumstances, a vein perforates, the patient may quickly bleed to death, blood being drained away directly from his heart to the exterior.

Varicose veins usually appear first in individuals between twenty and thirty years of age. They increase in severity until middle life and then usually remain stationary. The cause of varicose veins is not very well understood. Obstruction to the return of blood in the veins is clearly a factor; for instance, haemorrhoids are associated with cirrhosis of the liver; and direct pressure on veins, if it is gradual, causes them to dilate. On the other hand, sudden obstruction of veins leads to oedema whilst gradual obstruction may lead to the opening-up of the collateral circulation without dilatation. The fact that varicose veins occur as the result of pregnancy in the first two months when the uterus is not large enough to exert pressure has given rise to the idea that the tone of the veins may depend upon some disturbance of the internal secretions, and this view receives some support from the rapid disappearance of the varicosity with the termination of pregnancy. There is certainly a hereditary disposition to varicose veins.

Varicose veins in the legs give rise to a heaviness and aching in the limb, particularly after exertion. There is some swelling of the leg which disappears at night. As the veins dilate and the valves become incompetent there is perhaps set up a so-called vicious circle. The blood, instead of travelling up the internal saphenous vein, will travel downwards, pass by communicating channels through the deep fascia into the deep veins, travel up the deep veins, when some of it, reaching the saphenous opening, will escape again into the saphenous vein. Blood circulating round this vicious circle loses its nutritive properties, which is apparent in the poor condition of the skin and the loss of healing property when wounds occur. The skin in the neighbourhood of varicose veins is often atrophic and thin. There is frequently eczema.

Thrombosis is likely to occur in varicose veins as a result of injury or, perhaps, a mild infection. When a vein clots it becomes exceedingly tender and forms a cord running up the limb, surrounded by a dull red blush. Thrombosis is often accompanied by oedema of the foot. A wound of a varicose vein or the giving-way of the vessel in the floor of an ulcer leads to serious haemorrhage.

The Treatment of Varicose Veins.—Uncomplicated varicose veins

handicap the individual by restricting his activities, for, after standing or exertion, the limb is likely to swell, has a heavy feeling and aches. Varicose veins can be obliterated by the injection of some irritant chemical into the vein, which causes the blood to clot and sets up at the same time an aseptic inflammation, starting from the inner wall of the vessel. The intima is converted into granulation tissue which invades the clot, replaces it and transforms the vessel into a fibrous cord.

The following injection agents can be used: Sodium salicylate 30 to 40 per cent, sodium morrhuate 5 to 10 per cent, ethamoline, quinine 12 per cent with urethane 6 per cent, lithium salicylate 30 per cent with 1 per cent tutocaine.

The injection treatment of varicose veins can be carried out whilst the patient is walking about. By pressure on the vein above the site for injection, with the leg dependent, the vein is distended and the hypodermic needle inserted into the vein cavity. Care must be taken that the injection fluid is not allowed to escape into the surrounding tissues, or necrosis may result. It is also advisable to begin all injections with a small dose, as some people are found to be susceptible to quinine or salicylic acid, or even to sodium morrhuate. The usual dosage of the above solutions is 1 to 3 c.c.

After the injection the limb should be supported with an elastoplast bandage. There is no need for the patient to lie up. He is better walking about, because muscular movements help the venous return. Neither is there any danger of embolism occurring. The aseptic clot is firmly attached to the vessel wall.

During pregnancy veins should not be injected, and when there has been a deep thrombosis injection is only permissible below the knee.

The results are not always permanent. Sometimes the veins recanalise and very often other varicose veins appear, but the injection treatment can be repeated. In certain cases this treatment should be supplemented by division and ligation of the internal saphenous vein, close to its opening into the femoral vein. In order to select patients in whom this operation is necessary, Trendelenburg's test should be applied. For this the patient lies down, whilst the limb is raised so that the blood is emptied out of the veins. The thumb is then made to compress the upper end of the internal saphenous vein, and, while pressure is maintained, the patient is made to stand up. The pressure on the vein is then suddenly released. If the valves are incompetent, the blood will be seen to descend downwards from the groin to the lower part of the leg. This is a positive Trendelenburg's test. If the valves are intact, however, the dilated vessels will be seen to fill from

the periphery upwards. When Trendelenburg's test is positive and all the valves are incompetent, the internal saphenous vein should be exposed close to its opening in the deep fascia, two inches of its length removed and the two ends ligated. Every tributary entering the vein in the neighbourhood must be tied or success will not be achieved. The dilated veins lower down the limb should be treated by injections. It is also advisable to inject a sclerosing fluid into the peripheral end of the divided vein from the operation wound. Occasionally another ligature of the internal saphenous vein is needed just above the knee; and when the territory of the external saphenous vein is varicose this vein should be ligated where it sinks down between the heads of the gastrocnemius to join the popliteal vein.

Possibly only one-third of patients treated by injection alone are cured of their varicose veins. The percentage is likely to be higher when the internal saphenous vein is divided at the same time. The method, however, is so simple and makes so few demands on the patient's time that it has become the standard routine treatment. On the other hand it must be admitted that the permanent results from excision of the varicose veins are much more numerous than after injection treatment.

In the operative treatment the internal saphenous vein is ligated and divided at the top of the thigh, and then the whole of the internal saphenous vein down to just below the knee is removed through a number of short incisions along its course. Below the knee varicosities are removed through similar incisions, though it is not necessary to go further down than the lower third of the leg. When operating upon varicose veins it is a good plan to incise directly down to the deep fascia and dissect the superficial fascia from this structure, excising the veins from its deep surface. The nutrition of the skin is better preserved by this method and healing of the skin is more satisfactory. After excision of varicose veins it must be admitted that there have been a few cases of pulmonary embolism which have proved fatal. Results seem to show that embolism occurs chiefly when the operation has been done in individuals over fifty years of age. It is, therefore, wise to restrict operative treatment to young people.

When a varicose vein has become thrombosed the patient should not be laid up. A narrow band of sorbo rubber is placed along the course of the clotted vein as a pad. Over this an elastoplast bandage is applied from the heads of the metatarsals to the tubercle of the tibia. Pain is usually quickly relieved and by the end of a week the clot has shrunk very much and is well in process of organisation.

Varicose Ulcers

Ulcers are a very common complication of varicose veins. They occur more frequently in women than in men. Any slight injury may lead to a varicose ulcer, sometimes even a scratch. Owing to the poor nutrition of the superficial tissues because of the vicious circle which is in existence, these ulcers show very little disposition towards healing. They are usually on the inner side of the lower third of the leg. They are shallow ulcers with shelving margins surrounded by a reddish-brown discoloration of the skin, and very often by oedema. There may be a thin blue edge of new epithelium, which, however, never spreads very far. The granulations are weak; the exudation is watery when infection is slight, purulent when infection is more severe. It may be quite profuse. Varicose ulcers tend to spread in a circular direction, and may advance right round the limb, the result of which is a blocking of the lymphatic return, so that there is permanent oedema of the foot. Varicose ulcers may be extremely painful if a cutaneous nerve is exposed. These ulcers, if left untreated, may last for many years, healing in one part and breaking down in another.

They can usually be induced to heal if the patient lies in bed with his limb raised. The improvement of the circulation gained thereby leads to better nutrition of the tissues and cicatrisation and epithelialisation of the ulcer. But, as soon as the patient gets up and the stagnation in his veins is re-established, the ulcer breaks down. So it is quite useless as a method of curing ulcers permanently. The essential thing is to improve the venous circulation in the limb. This can only be done by treating the varicose veins. Unless the veins in the neighbourhood of the ulcer are obliterated, any treatment of the ulcer itself is ineffective. Sometimes when the veins have been injected the ulcer refuses to heal. In these cases there is nearly always found to be a perforating vein in the floor of the ulcer which has incompetent valves. These veins can sometimes be felt through the floor of the ulcer, though they cannot be seen, and can be injected. Care, however, must be taken not to introduce so much sclerosing fluid that it will reach the deep veins of the leg.

Another method is to excise the ulcer whole in such cases and ligate the offending vein. In the ordinary case, after carrying out injections, the foot and leg up to the tubercle of the tibia are enclosed in an elastoplast bandage which is allowed to remain on for 1 to 2 weeks. The best method of doing this is first to apply a longitudinal strip of elastoplast which runs downwards along the outer side of the leg, under the sole of the foot, and up along the inner side. This

prevents the circular turns of the elastoplast bandage cutting into the skin. There may be considerable discharge under the bandage but this is of little account and, indeed, it may help the healing, because, as Besredka has shown, the nutrient medium in which organisms grow soon comes to contain the products of bacterial activity in such concentration that the bacteria are inhibited from further growth. It has also been suggested that an immunity reaction is set up by a kind of local vaccination of the tissues. Every time the bandage is removed any veins which can be detected are injected. During the treatment the patient walks about. Muscular movement is an essential part of the procedure.

The results of this treatment are extremely good. Many ulcers which have resisted treatment for years heal and remain healed. It is useful, however, for the patient to wear an elastic stocking for some time after the cessation of treatment. Should there be a recurrence the same treatment will again be effective.

Certain patients cannot stand the application of an elastoplast bandage because a severe form of eczema is set up. In these cases the method must be stopped and it is best to apply an Unna's stocking. A paste is made of:

Zinc oxide . . .	3 parts
Gelatin . . .	3 „
Glycerin . . .	5 „
Water . . .	9 „

which is solid at normal temperature but can be melted in warm water. The molten jelly is painted right over the leg, including the ulcer, and then the limb is covered with a single layer of gauze bandage. This itself is painted over with more molten gelatin. Four or five layers of bandage are applied in this way. As the jelly sets it contracts and has a similar effect in supporting the circulation as an elastoplast bandage, though it is not so effective.

Sometimes in order to hasten the epithelialisation of varicose ulcers it is a good plan to insert small Braun grafts into the granulations underneath the elastoplast bandage. At other times it is desirable to excise an ulcer and put on an immediate Thiersch graft. The whole ulcer is removed down to and including the deep fascia covering the muscles. This leaves a loose reticular tissue which is very favourable for grafting. Thiersch grafts are then put into place (see page 15).

Certain ulcers are extremely irritable and painful. They are found, as a rule, overlying the malleoli. They can be treated effectively by exposing the internal saphenous nerve a short distance below the knee, as it runs downwards with the internal saphenous vein, and injecting it with alcohol. This denervation of the ulcer frequently

leads to healing just as a sympathectomy will do. Indeed, Leriche has shown that periarterial sympathectomy of the femoral artery will alter the circulation in the limb, including the ulcer, for a sufficiently long time for the infection to clear up and the ulcer to heal. He advocates this treatment, combining it very often with Thiersch grafting when the infection has been lessened.

CHAPTER X

DISEASES OF THE LYMPHATIC SYSTEM

Injuries

Wounds of lymphatics occur but they are not usually serious unless one of the large lymphatics is divided, when there may be a profuse flow of lymph from the wound for a few days. This flow, however, soon ceases and the wound heals. Sometimes, after removal of the axillary glands for carcinoma of the breast, this lymphorrhoea is seen; for the afferent lymphatics from the arm are cut across, but being invisible are not ligated. It gives rise to collections of fluid under the flaps which very often require aspiration. The thoracic duct is occasionally injured during an operation at the base of the neck. The damage is recognised by the wound filling up with serous fluid. No blood comes from the short end of the duct, because there is a valve where it opens into the innominate vein. If the accident is recognised in time, the duct had better be ligated above and below the site of the injury. There are records of the aperture in the duct having been sutured and even of the implantation of a divided duct into the subclavian vein. If the injury is not recognised at the time of the operation, it will soon become evident subsequently by the profuse flow of lymph which comes from the wound. This may be serious because it leads to rapid wasting of the patient. As a rule, if the patient is kept on a fat-free diet and fed almost solely on proteins and carbohydrates, and the wound plugged, the flow will soon cease; but if he is losing strength rapidly, it is better to open up the wound, expose the divided duct and ligate it. The collateral circulation is easily and quickly established after ligature.

Lymphangitis

Inflammation of the lymphatics may be acute or chronic. Acute lymphangitis is sometimes reticular when it affects a network of lymphatics in a certain area, or tubular when it affects the lymphatic

trunks. Very little is known of inflammation of the deep lymphatics. As a rule, it is the superficial lymphatics which are obviously recognised as being inflamed. Disease is nearly always due to infection by the streptococcus which gains entry through the skin, sometimes through a very minute wound.

Reticular lymphangitis of the skin is indistinguishable from erysipelas. When it affects the deeper tissues it is indistinguishable from cellulo-cutaneous erysipelas.

Tubular lymphangitis is recognised by red streaks passing up from the site of entry of the infecting agent towards the nearest lymphatic glands. In the arm the streaks nearly always go up to the axilla and in the leg they pass up to the groin. The lymphatic glands into which the lymphatics drain are enlarged. These red streaks are due to a hyperaemic inflammatory reaction around the course of the lymphatic. The lymphatics themselves are filled with desquamating endothelial cells and polymorphonuclear leucocytes. As a rule, the inflammatory condition settles down in a few days. The glands draining the parts may suppurate, and sometimes along the course of the lymphatics inflammation becomes localised, more intense, and gives rise to an abscess. When the lymphangitis has subsided there may remain a fibrous cord, which is the cicatrised clotted lymphatic vessel. These fibrous cords are sometimes seen at the bend of the elbow, where by contraction they pull up a fold of skin.

In the treatment of lymphangitis it is extremely important not to carry out any operative treatment unless there is an actual collection of pus. Premature incisions are very likely to disseminate the infection and perhaps lead to a general septicaemia. The limb should be surrounded by hot fomentations and kept at rest, either on a splint or between sandbags. Penicillin or sulphadiazine should be administered.

Chronic lymphangitis sometimes arises from an acute attack. Erysipelas, for instance, may cause the narrowing of some lymphatic trunks and obliteration of others. After a radical operation for carcinoma of the breast there is sometimes a chronic lymphangitis which causes obstruction of the lymph-flow along the limb. There may also be a chronic lymphangitis associated with a deep thrombophlebitis. Finally, in tropical countries, the same chronic inflammation may arise by the entrance into the lymphatics of the *Filaria sanguinis hominis*.

Chronic lymphangitis is important surgically because it obstructs the lymphatic vessels and interferes with the return of lymph from the limb so that oedema results. This oedema is nearly always confined to the tissues superficial to the deep fascia. It causes great hyper-

trophy of the skin and subcutaneous tissue. The skin becomes coarse in texture and may have warty growths upon it. It is also liable to attacks of infection, particularly with the streptococcus. These attacks obliterate more lymphatics and render the condition worse. The skin and subcutaneous tissue become hypertrophied and the whole limb is very much increased in size. It becomes an elephantiasis.

In young people elephantiasis of the lower limb sometimes appears without there being any recognised cause. Occasionally there has been an attack of erysipelas of the limb, but more often a chronic lymphangitis has come on insidiously without the patient being aware of it.

In the tropics elephantiasis is due to the adult filarial worm lodging in a large lymphatic vessel in the groin, where it sheds its ova, which escape into the blood-stream. The recognition of these ova on blood examination establishes the diagnosis. At the beginning of the attack there is a swelling in the groin accompanied by tenderness and a high fever. The swelling becomes almost cystic and fluctuating. The fever gradually subsides but the lymphatics become blocked so that elephantiasis of the affected leg, of the scrotum or the vulva, comes on to an extreme degree.

In the treatment of chronic lymphangitis assistance should be given to the return of the lymph by elevating the limb whenever it is possible and by the use of elastic stockings or bandages. In the idiopathic elephantiasis of young people, met with in this country, an operation devised by Kondoléon is the most satisfactory. In this two incisions are made, one down the inner side of the whole length of the limb, and one on the outer side, reaching right up to the gluteal region. These two long incisions are interrupted in the region of the knee. The skin is turned back on each side in flaps and as wide an area as possible of subcutaneous tissue, including the deep fascia, is removed. There may be considerable haemorrhage, so that the operation had better be done in two stages, first the outside and then the inside. The results of this operation are fairly successful. Two large strips of diseased subcutaneous tissue have been removed. At the same time the lymphatics beneath the deep fascia have been allowed to come into contact with the superficial diseased tissue and, by establishing new connections, they are supposed to assist in carrying away the lymph. In tropical elephantiasis very large areas indeed of subcutaneous tissue of the limbs and scrotum can be removed.

Tuberculous Lymphangitis

Tuberculous lymphangitis is sometimes seen along the course of a lymphatic running from a lesion of the skin to the draining lymphatic

glands. It is recognised because along the course of the lymphatic characteristic nodules develop which come to the surface and form typical tuberculous ulcers.

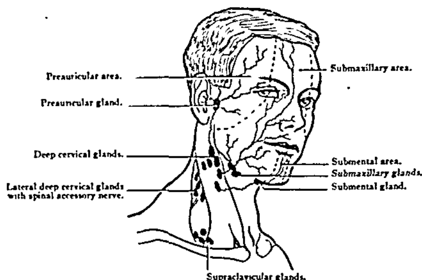
Treatment is directed towards the primary lesion and the neighbouring glands. Sinuses may be scraped or the lesions actually excised.

Diseases of the Lymphatic Glands

Acute Lymphadenitis

Acute lymphadenitis is an infection of the lymphatic glands with pyogenic organisms, secondary to a septic focus in the area which the lymphatic gland drains. Thus when there is an infection of the lower limb the vertical group of the inguinal glands becomes affected. The oblique inguinal glands become enlarged when the infection is in the region of the anus, the glutei, the external genitals or the lower part of the abdominal wall from the umbilicus downwards. When the infection is in the upper limb the axillary glands become enlarged. They are also affected if the infection is on the chest, the upper part of the abdominal wall and the upper part of the back. The lymph from the scalp, behind a vertical line running through the external auditory meatus, drains into lymphatic glands in the posterior triangle of the neck. Lymph from the temporal region of the scalp, face, outer halves of the eyelids and the front of the external ear drains into the parotid gland, whilst the lymph from the posterior half of the external ear drains into a gland situated on the mastoid process. Lymph from the frontal region of the scalp, the forehead, the nose, *the inner halves of the eyelids, the whole upper lip,* cheek and outer one-fourth of the lower lip flows into a lymphatic gland which is resting on the surface of the submaxillary salivary gland. This submaxillary gland also drains lymph from the side of the tongue, inner side of the cheek and the floor of the mouth. Lymph from the front of the tongue, the anterior part of the floor of the mouth and from the middle two-fourths of the lower lip drains into the submental gland immediately under the chin. Lymph from the back of the tongue, the fauces, including the tonsils, drains into the digastric, or tonsillar gland, situated on the internal jugular vein, where the digastric muscle crosses it. Lymph from the tongue and the floor of the mouth also passes to the jugular chain of glands as far downwards as the crossing of the vein by the anterior belly of the omohyoid muscle. Lymph from adenoids and the naso-pharynx may pass into the upper deep cervical glands, but some of it goes into the retro-pharyngeal glands, which may thus become enlarged in infections of this area.

Lymphatic glands must be regarded as very important structures in combating infection. They act as filters taking the organisms out of the lymph-stream, preventing them from entering into the general circulation, and at the same time, owing to their reactions to the presence of these organisms, they probably are very active in the production of immune bodies. Hence, lymphatic glands are struc-



Lymphatic drainage from the face.

tures which should be very carefully preserved, especially when there is any infection in the territory which they drain.

If the patient recovers, the inflammatory reaction will subside and the gland return to normal. If the infection is more severe, the reaction will spread to the surrounding tissues so that there is a cellulitis outside the gland, called periadenitis. Within the gland itself an abscess may form. In other cases the infection subsides, but the gland becomes fibrotic and remains as a hard nodule. In acute lymphadenitis, therefore, it is most important to treat the primary infection. If this can be induced to heal, then the gland will usually return to normal. It is very dangerous to interfere with lymphatic glands in the presence of an active infection of its appropriate territory, because the removal of such glands, or even an incision, may lead to general dissemination of the disease by the blood-stream. The local treatment of the gland itself should be directed to assisting, as far as possible, the inflammatory reaction which is combating the infection. This is best done by the application of heat. When, however, an abscess forms in the gland this must be opened; but such operations should not be premature and the surgical intervention should be as small as possible.

In the neck these abscesses are opened by a procedure called Hilton's method. The skin should be incised in a transverse direction which leaves the least noticeable scar. The deep fascia is cut through. After this the abscess cavity is penetrated by a closed blunt-nosed pair of Spencer-Wells forceps, which will glide between important structures without injuring them. Penicillin is indicated if the organism is susceptible.

Chronic Septic Lymphadenitis

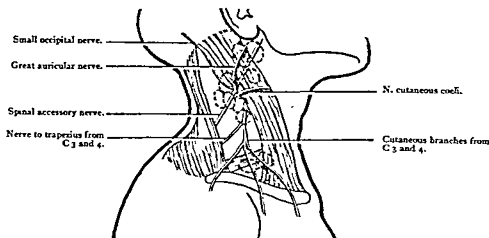
Chronic septic lymphadenitis is associated with a chronic septic infective focus in the territory drained by the gland. It is more often seen in the neck than elsewhere in the body. It may be due to infections of the scalp, eyes, the middle ear, mouth and pharynx. When the primary focus is removed the glands will return to their normal size. The treatment is therefore directed to the primary focus.

Tuberculous Lymphadenitis

This disease of lymphatic glands is seen more frequently in the neck than elsewhere in the body. As a rule, the tubercle bacillus gains an entry through the tonsils, or the mucosa of the bronchi and the alimentary canal. The lymphoid tissues are concerned with the production of immune bodies. Such lymphatic organs as the tonsils, Peyer's patches in the small intestine, and the appendix vermiformis may be regarded as the first lines of defence in the body against infection. These lymphatic areas appear to have an attraction for organisms, or rather, the mucous membrane overlying them allows the organisms to penetrate into their lymphatic tissue. If a drop of a culture of the *Bacillus prodigiosus* be placed on the inner side of the cheek it can afterwards be recovered from the tonsil, but not from any other part of the mouth or pharynx. In the lymphoid tissue of these organs the bacilli are destroyed, their destruction being accompanied by an immune reaction. If, however, the function of the tonsil is interfered with by attacks of septic inflammation, then the tubercle bacilli which have entered may gain a footing and grow, and may even pass onwards along the lymphatics to the second line of defence in the body, the lymphatic glands. It is not surprising, therefore, that tuberculous glands are found more frequently in the neck than elsewhere. Since the portal of entry is in most cases a tonsil, it is the digastric gland which commonly enlarges first. Glands, however, may enlarge in the posterior triangle from lesions of the scalp, and in the parotid region from affections of the conjunctivae. Through both these paths tubercle bacilli may enter the glands. As a rule the infection of a

lymphatic gland is a lymph-stream infection in the way described, but sometimes apparently the lymphatic glands are infected through the blood-stream. This can only happen if, from some other tuberculous focus in the body, the disease has eroded into a blood-vessel. Infection of lymphatic glands by this means must be considered a more serious disease as it indicates that the resistance of the body has broken down twice. Tuberculous glands just above the clavicle which are sometimes found enlarged may be infected from the blood-stream, though they may be simply an extension from the tuberculous lymphatic glands in the mediastinum. As the bacillus grows in the lymphatic gland it changes it into a mass of granulation tissue in which caseous centres appear, coalesce and frequently liquefy to form cold abscesses. In other cases caseation fails, the gland showing fibrotic changes only. The disease is first limited by the capsule of the gland, but should it extend further, a periadenitis is caused, the tuberculous granulation tissue invading the surrounding tissues. In this granulation tissue, caseation and softening may ensue, so that a cold abscess in the gland may be continuous with a cold abscess lying between the structures of the neck. Such cold abscesses are liable to spread between the fibres of the sterno-mastoid muscle, reach the subcutaneous tissue, cause necrosis of the skin, and form a tuberculous sinus.

Clinically, tuberculous glands in the neck appear as painless swellings. One single gland may be enlarged, the commonest being



The relationship of tuberculous glands to the nerves of the neck.

the digastric gland, as above mentioned. If the disease has spread to other glands there will be a noticeable difference in the amount of enlargement, the greatest-sized gland being that which was first infected. Sometimes the disease is very extensive, affecting the glands in the anterior and posterior triangles of both sides of the neck.

Softening of the gland is appreciable by fluctuation. An abscess which becomes subcutaneous very often communicates by a narrow channel in the sterno-mastoid with a deep glandular abscess (collar-stud abscess). There is not usually any increase of body temperature accompanying the disease.

The diagnosis of the tuberculous nature of a chronically enlarged lymphatic gland in the neck can only be made when all possible primary foci of infection have been eradicated. If chronically infected tonsils or decayed teeth or adenoids have been removed and the glands persist, then almost certainly the cause is the tubercle bacillus. Tuberculous glands are matted together, and this, *with their varying size*, distinguishes them from the enlarged glands of Hodgkin's disease in which there is no periadenitis, so that the glands remain movable. In this disease a whole group, as a rule, enlarges simultaneously, its individual members being of approximately the same size. Also, glands in the other parts of the body are likely to be enlarged, as well as the spleen. With an excessively large spleen accompanied by glandular enlargement, the diagnosis is more likely to be leukaemia. A blood count will confirm the suspicion. Malignant glands are painless at first, hard, not tender and very often fixed to the prevertebral fascia so that they cannot be pushed out of their position. A branchial cyst may sometimes very strongly resemble a liquefied tuberculous gland especially when it has become infected (see page 260).

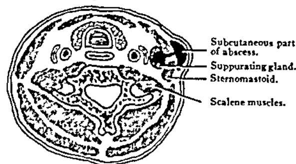


Diagram of a collar stud abscess with the stem traversing the sternomastoid muscle.

In the treatment of tuberculous glands it is essential first to ensure that there are no portals of entry for the tubercle bacillus, such as diseased tonsils or decayed teeth. The appropriate treatment for infections of the mouth, pharynx, nose, eyes and scalp must therefore be carried out as a primary measure. The patient must be put under the best hygienic conditions possible, which include abundant nourishing food rich in vitamins, fresh air and sunlight. No direct treatment of the glands in the neck is required in early cases. If a cold abscess forms or if a gland remains chronically enlarged in spite of the removal of primary sources of infection and the institution of a good hygienic régime, surgery is indicated.

A minor procedure is the aspiration of the cold abscess in the gland which may induce cicatrisation of the gland and lead to cure,

but, as a rule, it is preferable to operate and remove the persistingly enlarged tuberculous glands, resistant to treatment, by open operation. Such removal may mean an extensive dissection of the neck. If there are large numbers of glands involved it is best to make two curved transverse incisions which run across the sterno-mastoid and from which both anterior and posterior triangles can be reached. The danger of operating upon tuberculous glands in the neck is that of injury to nerves which may run very closely attached to the gland capsules in hard periadenitic tissue. The nerve which is most likely to be damaged is the spinal accessory in the posterior triangle. It frequently runs right through a mass of diseased glands. An injury of this nerve is not without its consequences. It leads to some drooping of the shoulder, wasting of the trapezius muscle and frequently an aching in the shoulder due to the fact that other unparalysed muscles have to support the weight of the arm. If tuberculous glands are thoroughly and carefully removed, a cure is usually speedily brought about, but even with the most careful operating small glands harbouring the tubercle bacilli may be left behind and increase very much in size subsequently so that there is a recurrence of the affection. When the disease has passed beyond the capsule of the gland and has formed an abscess in the surrounding tissues, the walls of which are formed by the muscles, vessels and nerves of the neck, it is much more difficult to perform an excision. Under these circumstances the abscess may be opened and its caseating curdy contents curetted away. Even when there is no abscess outside a gland which is immovably fixed to surrounding parts, it is sometimes wise to scrape out the parenchyma of the gland until the fibrous capsule is reached. This operation, which is decried by some surgeons as being incomplete, is very often strikingly effective and leads to a cure of the condition.

Every effort should be made to avoid a sinus leading down to a tuberculous gland, because this is very likely to be infected secondarily with pyogenic organisms, when it is found that the combined disease is very difficult to cure. Prolonged open-air treatment may be effective, but if such a sinus persists, an operation becomes necessary, and, now that penicillin is available against pyogenic contaminators, can be the more readily resorted to. Indeed, instead of aspirating an extracapsular cold abscess, much time can be saved by operating before it has penetrated the skin. The originating gland must be excised together with all tuberculous skin or connective tissue. In a collar-stud abscess both cavities must be thrown open into one, dividing the sternomastoid in part if necessary. The large wound is packed with vaseline gauze after sprinkling it with penicillin and sulphathiazol powder and left for a week. Penicillin systemically

should be given for five days. With this treatment, and a weekly dressing, the wound will heal comparatively quickly and without a very disfiguring scar.

X-ray therapy has been used to a considerable extent for tuberculous glands in the neck and good results are claimed for it.

It is quite rare to find tuberculous glands in the extremities, but occasionally they are found in the groin and more commonly in the axilla, where sometimes they are due to an extension from the base of the neck. Excision had better be employed in these situations.

In the abdomen tuberculous glands are found most frequently in the lower part of the mesentery where they drain the appendicular and caecal regions. Infection of mesenteric glands is an exceedingly common phenomenon and frequently passes unnoticed. Very many individuals of the community have old calcified tuberculous mesenteric glands.

These glands are infected from drinking tuberculous milk. They only give rise to symptoms when they enlarge so as to cause interference with the mesenteric nerves and hence give rise to attacks of abdominal pain, or when the disease spreads from the gland to the peritoneum, setting up tuberculous peritonitis. Children are more often affected than adults with attacks due to tuberculous mesenteric glands. When a child is subject to short-lived attacks of abdominal pain, perhaps accompanied by sickness, two lesions should always be thought of, namely, appendicitis and tuberculous disease of the mesenteric glands. When the pain is due to this latter affection there is frequently tenderness to the left of the umbilicus. As a rule only hygienic measures are called for in the treatment of tuberculous mesenteric glands, but sometimes it is wise to operate with the object of removing the portal of entry, the appendix vermiformis. The glands themselves can be taken out, but it is an operation which is associated with some risk of injury to the blood-supply of the intestine and therefore it is often wiser to leave the glands in the body.

The complications of tuberculous mesenteric glands, obstructions from adhesions and tuberculous peritonitis, are considered elsewhere in this book.

Hodgkin's Disease

Hodgkin's disease is an infection of the lymphatic glands of young people. Its cause is unknown, though it is suspected that it is due to an ultramicroscopic virus. It appears as a painless enlargement of a group of glands in the neck. The glands are not usually very large. They are all of approximately the same size and are very freely movable on one another and the surrounding structures. Not only may the

glands in the neck be enlarged but the glands in the axillae, the groins, in the abdomen and the chest. There is also enlargement of other lymphatic structures in the body. Thus the spleen becomes very big and collections of lymphocytes may form in Glisson's capsule of the liver. In the abdomen also Peyer's patches may become so hypertrophied that intestinal obstruction results, though this is a very rare complication. In the thorax the enlargement of glands may cause pressure upon the innominate veins so that there are enlarged tortuous veins on the surface and the patient suffers from breathlessness. The blood may show simply the changes of a secondary anaemia, though sometimes there is an eosinophilia. Deposits also occur in the bones and can be recognised in skiagrams.

The diagnosis of Hodgkin's disease is assisted by such examination of the blood and an X-ray of the thorax which may show enlarged mediastinal glands. A biopsy will render it certain.

There is no known effective treatment for Hodgkin's disease, though some claims have been made for a vaccine prepared from the supposed virus, and sometimes arsenic will check the disease and cause it to regress for considerable periods. X-ray therapy has a similar and very remarkable effect. The removal of a large mass of glands from the neck will sometimes give relief for a very long time.

CHAPTER XI

GANGRENE

Gangrene, or necrosis, is the term given to massive death of the tissues. Gangrene is classified as follows:

1. Secondary or Symptomatic.
2. Traumatic.
3. Physical and Chemical.
4. Infective.

Signs of Gangrene.—Gangrene is seen typically in an extremity when there is some interference with the main blood-supply. Signs of gangrene of a part of the limb are loss of pulsation of its vessels, loss of heat, loss of sensation, loss of function and change in colour. The gangrenous part is at first pale. It feels cold. If the blood from the capillaries be expelled by light pressure of the finger it fails to return or returns very slowly. There is no movement possible in the limb itself and it is quite insensitive to pricking.

There are two main forms of such gangrene, dry and moist. Dry gangrene occurs in limbs which contain very little fluid, such as limbs affected with arteriosclerosis. The blood-supply has become gradually less whilst the venous return has remained quite free. When gangrene occurs in such limbs the tissues shrivel up and dry, the part is wrinkled and becomes a dark brown, green or black in colour, due to changes in the haemoglobin which has escaped from the blood-vessels. Above the black area there is a zone of hyperaemia which is an inflammatory reaction at the edge of the dead tissue. This inflammatory area ultimately becomes replaced by a zone of granulation tissue which causes the dead part to separate. The red line is called the line of demarcation. Separation of the soft parts is much more easy than throwing-off of dead bone, so that when the extremity has been cast off there often remains a conical stump with the bone projecting through. In moist gangrene death takes place with the limb full of fluid. It is very likely to occur when there is an obstruction of a blood-vessel in a healthy limb, particularly if, at the same time, the main vein is blocked. Even without such venous obstruction the sudden cutting-off of the arterial stream is sufficient to cause passive hyperaemia. The dead tissues again pass through a colour

change, from white to purple, green to black; blebs appear on the surface; infection supervenes and the dead part of the limb ultimately becomes a mass of putrefying flesh. In moist gangrene a line of demarcation also occurs and the dead part is separated as a slough.

SYMPTOMATIC GANGRENE

Symptomatic or secondary gangrene is due to a diminution in the main arterial supply of a limb. Thus, it can occur as a result of weak cardiac action after a severe attack of typhoid fever, as a result of embolism, or of diseases of the arteries which cause their narrowing. Secondary gangrene is divided up into the following sub-varieties:

(a) Embolic.
(b) Senile.
(c) Thrombo-angeitis Obliterans.
(d) Diabetic.
(e) Spastic.

Embolic Gangrene.—The embolus which blocks the artery may be a vegetation from a diseased cardiac valve which has become loose or a detached atheromatous plate in one of the arteries. The embolus lodges most commonly at the bifurcation of an artery, hence it is seen particularly at the lower end of the popliteal space. When such an embolus occurs there is a sudden acute pain at the site of the impaction. Pulsation of the arteries below is lost, the limb becomes cold, insensitive and paralysed. The skin is pale at first but, since the veins are unobstructed, congestion is likely to follow and then all the changes seen in moist gangrene occur. If there has been, previously, generalised arteriosclerosis, then the gangrene may be dry in type. The gangrenous process, while beginning peripherally, gradually spreads up the limb. It is arrested most commonly in the neighbourhood of a joint where, owing to the abundant vascular supply, vitality can be conserved.

The diagnosis of embolic gangrene is made on the suddenness of the onset, the acute pain at the place where the embolus is lodged, and the presence of a disease which can give rise to an embolus. When the case has been diagnosed the limb should be raised, wrapped up in cotton-wool and preparations made for the extraction of the embolus, if the patient's condition will stand such an operation, as soon as possible. The quicker it is done the better. The site of impaction is known almost certainly from the pain and absence of pulsation below. The artery must be exposed here, incised longitudinally, the embolus and the surrounding clot removed and the vessel sutured. Heparin, followed by dicumarol are given to retard clotting. Unfortunately, in spite of this, although the embolus is removed, thrombosis is likely to reappear at the site of the impaction

and the circulation cut off. However, quite a number of successes have been recorded, so that the operation should always be carried out. Even though clotting should occur in a day or two there would be given an interval for the anastomosis to open up as the lumen of the vessel is gradually narrowed.

Senile Gangrene.—Senile gangrene is due to degenerative changes in the vessels which cause endarteritis obliterans of the small arteries. With this there is frequently associated atheroma of the large trunks. At the same time weak cardiac action may contribute to the local circulatory failure. As the arteriosclerosis progresses the amount of blood flowing into the limb is gradually diminished in quantity until a point is reached at which there is just a sufficient amount of blood reaching the extremities of the toes to maintain their vitality. If, under these circumstances, the toes are subjected to a slight injury which induces an inflammatory reaction with perhaps local thrombosis of some of the capillaries in the neighbourhood, gangrene will occur because the vessels cannot dilate even sufficiently to supply the slight increase of blood necessary to preserve the life of the tissues. So that gangrene can occur from the very small damage due to the cutting of a corn in an old person, or by exposure to cold, because here also the return to normal demands the same inflammatory reaction.

There are often premonitory symptoms in old people with arteriosclerosis. They complain of coldness in the feet, fatigue after exercise and, perhaps, numbness and tingling. Then there is the peculiar phenomenon of intermittent claudication. In this the patient will walk for a short distance and then will be brought up sharply by pain in the legs, usually the calf muscles. This is attributed to the accumulation of waste products of muscular contraction which cannot be carried away owing to the deficient circulation. The patient is forced to stop and rest. After a while the pain passes off and he can resume his walk but, within a short distance, the pain will return. When these symptoms are present every precaution should be taken against any slight injury or exposure to cold.

When the gangrene comes on it nearly always begins at the extremity of one of the toes, where there appears a discoloured area which ultimately becomes black. The gangrene is dry in type so that the toe becomes shrivelled up. The process frequently spreads from one toe to another, up the foot and perhaps well up the leg. As a rule, in these arteriosclerotic cases the pulse of the dorsalis pedis, the posterior tibial and the popliteal arteries is absent. An X-ray examination sometimes gives some idea of the extent of the disease, because calcification is rendered evident and will outline the course of the anterior and posterior tibial arteries in the leg. Calcification may also

be seen in the popliteal and the femoral arteries even right up to Poupart's ligament. Senile gangrene is usually accompanied by very severe pain owing to the gradual death of the nerves in the gangrenous part.

The only treatment for senile gangrene is amputation, and experience has shown that in this type of gangrene the best place to amputate is in the lower third of the thigh above the knee joint. If the limb is amputated below this level gangrene of the flaps will nearly always occur and necessitate a subsequent higher amputation. This should be avoided, as these old people are often in a weak state of health and are quite unable to withstand two operations, whereas they can usually go through a single one. It is sometimes difficult to make a patient realise that an amputation is necessary for gangrene at the extremity of a toe; particularly is it difficult to persuade him to have his leg amputated above the knee joint. If the surgeon will withhold his hand for a short time, the breaking down of his fortitude by the extreme pain which he suffers and the loss of sleep are likely to make him amenable to persuasion.

When the patient is too ill to be subjected to an amputation, the limb should be covered with aseptic gauze, wrapped up in wool, and raised on a pillow, whilst the patient should receive supportive treatment and opium to relieve his pain.

In amputations for senile gangrene a tourniquet should not be employed as it may damage the hard femoral artery and perhaps lead to its thrombosis. There is frequently extremely little bleeding during these operations.

Thrombo-Angeitis Obliterans (Buerger's Disease).—This is a disease which occurs in youngish adults, as a rule during the fourth decade of life. The nature of the disease is not definitely known, but it is an inflammatory affection of the large arteries of the limbs and the veins, which is patchy in its distribution. It affects the lower limbs far more than the upper limbs. It is progressive in nature but intermittent in its progression, though, sometimes, the disease seems to die down altogether. A length of one of the main arteries shows an inflammatory reaction which causes a great thickening of the intima, spreads through the media to the adventitia, and converts the soft artery into a rigid structure forming adhesions with the surrounding parts. Thrombosis occurs in the affected area. A similar condition is seen in the veins, not only those accompanying the artery, but also sometimes in the subcutaneous vessels. The symptoms of the condition are coldness, numbness and tingling felt in the feet, and intermittent claudication already described under senile gangrene. At this stage the dorsalis pedis and the posterior tibial artēries cannot be felt

to pulsate. Ultimately the disease will progress until gangrene supervenes. This is often initiated by a paronychia of the great toe which resists all treatment, goes on to suppuration and finally to gangrene, beginning at the tip of the toe.

The treatment of the condition is very different from that of senile gangrene. In the latter disease all the arteries are affected, but in thrombo-angeitis obliterans part of the arterial tree is healthy. In the unaffected parts the vessels are capable of dilatation and so giving an increased blood-supply to the limb. If these alternative paths can be opened up, gangrene can very often be averted, or postponed for a very considerable time. The operation which does this is division of the vasoconstrictor nerves going to the limb. Even in the early states of gangrene the operation is advisable, though, when the disease is more widespread, amputation is the only course to take. It is, therefore, important to form some estimate of the condition of the arteries of the limb. It is not easy to form an accurate idea of the functional power of the arteries. Many things must be taken into consideration. The dorsalis pedis and the posterior tibial arteries are almost certain to have lost their pulsation when symptoms arise. If the popliteal artery also is thrombosed there must be extensive block. If the limb be raised it will become pale up to a certain level, and when it is hung downwards it becomes congested and dusky in colour. These changes are due to the loss of compensatory action of the vasomotor system with change of position. The quicker they take place the more serious is the vascular disturbance. Patients have often noticed this change in the colour of the limbs, and in the later stages when pain disturbs their sleep they frequently get relief by hanging the limb downwards over the side of the bed. Another test which has been devised is the reaction which is obtained on the intracutaneous injection of histamine. At several points along the limb 0·1 c.cm. of 1/1000 histamine, containing ½ per cent novocaine, is injected intracutaneously. There is, first, a cyanotic flush, then a hyperaemic flare, and finally a wheal appears. If, at a certain point, a flare does not appear, there the circulation is very deficient. Amputation, if necessary, must certainly be done above this point. Other methods of determining how much of the arterial tree is diseased also depend upon vasomotor response or the cutting-out of vasoconstrictor impulses going to the limb. Thus, a spinal anaesthetic may be used in the case of the lower limb when, if there is no power of vasodilatation left, the temperature of the skin will not be raised. A similar test is the injection of typhoid vaccine which causes a general rise of temperature and in particular an increase in the temperature of the skin. Neither of these tests is advisable. The first for such a purpose is

unjustifiable; the second puts the patient to a great deal of unnecessary suffering. Vasomotor nerves may be cut out by the injection of the posterior tibial nerve behind the ankle joint, by injecting around it 2 per cent novocaine, when the temperature changes in the sole can be estimated. In the case of the upper limb it is simple to anaesthetise the ulnar nerve behind the internal condyle. Another method is to place the patient in a cradle and subject him to radiant heat. The temperature of the air inside the cradle should be raised to about 50° C., and the temperature of the room had better be low to begin with, in order to get a good response. The limbs to be tested are left outside the tent. In a normal limb the temperature will quickly rise to perhaps 33° C. within fifteen minutes or so, whereas in a diseased limb where the vasomotor response is interfered with, the rise will be much more gradual, probably take three times as long and not rise so high, perhaps only reaching 23°. After anaesthetising the nerves, as described above, a rise in temperature to approximately the same level, 33°, will be found in the normal limb but to a less height in the diseased limb. These tests, which depend upon measuring the temperature of the surface of the body, are not altogether reliable, because the superficial vessels may be intact, whilst the deep vessels are the seat of disease. A method of testing the efficacy of the circulation through the muscles is the use of an ergometer. This consists of a posterior wooden splint, to which the limb is fixed, and a hinged foot-piece. The foot-piece is kept in a vertical position by a weight attached to a cord running over pulleys. It is arranged so that plantar flexion of the foot raises the weight. If the supply of the blood to the muscles is deficient, the number of times the weight can be raised is very much diminished, pain will come on in the calf of the leg, and perhaps only one-third of the contractions which a normal limb can perform before discomfort comes on is possible. This is a test which produces the same phenomena as those of intermittent claudication.

Whenever it is possible to prove that there is some vasomotor response in a limb affected with Buerger's disease, it is worth while performing a sympathectomy. In the case of the lower limbs the second, third and fourth lumbar sympathetic ganglia are removed. There is an immediate blush of the lower limb produced, which lasts for about 48 hours and then, to a considerable degree, passes off. The limb remains permanently warmer and the symptoms of claudication and coldness and numbness disappear.

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cases the fingers may be lost. The disease is nearly always symmetrical, affecting both sides of the body. Patients who suffer from it are severely handicapped in the winter, when they nearly always get chilblains which frequently ulcerate, producing indolent sores.

The nature of Raynaud's disease is not perfectly clear. It may not even be a vaso-constriction of the digital vessels. Certain observations indicate that the coldness and blueness of the fingers may be due to a vaso-dilatation of the palmar arch with a diversion of blood from the fingers and a passive collapse of the vessels.

The condition may be associated with secondary anaemia or syphilis.

Mild cases require no treatment but the protection of the hands from exposure to cold. The individual should never wash in cold water, should always carefully dry his hands after washing and should wear warm gloves out-of-doors. Secondary anaemia should be corrected, or syphilis treated.

Sometimes in severe cases relief can be given by dividing the vaso-constrictor nerves going to the upper limbs. The vasoconstrictor nerves leave the cord in the second to the twelfth thoracic roots and pass into the sympathetic cord by the white rami communicantes. They leave the sympathetic cord by the grey rami communicantes going to the individual spinal nerves. The vasoconstrictors of the arm can be completely severed by removal of the stellate ganglion and the second thoracic ganglion. This operation is carried out by an incision just above the clavicle which exposes the scalenus anticus. This muscle is divided shortly above its origin, the phrenic nerve having been retracted, when the subclavian artery and the pleura can be pulled downwards, exposing the stellate ganglion to the inner side of the inferior thyroid artery on the neck of the first rib and the sympathetic cord below. When this operation has been performed the hand immediately becomes warmer than that on the opposite side of the body and it assumes a reddish colour. This reaction lasts for 48 hours, at the end of which the vessels regain their tone somewhat and the hand ultimately becomes paler than the affected hand on the opposite side of the body, but the attacks of spasm, typical of Raynaud's disease, disappear or become much less in severity, whilst the patient loses his subjective symptoms. The removal of the stellate ganglion necessarily removes the pupillo-dilator fibres which pass from the first thoracic nerve to the sympathetic. The result is that the pupil of the eye on the operated side remains smaller than that on the other side, whilst owing to the loss of innervation of the smooth muscle of the orbit, slight enophthalmos is evident. Unfortunately the results of this operation are not always permanent and many relapses have occurred which cannot be attributed to inefficient operating. It would appear

is reached. The other is an extraperitoneal method. It demands a separate incision on each side of the body. The best incision is an oblique one very similar to the incision for exposing the kidney, but more horizontal, the anterior extremity being on the level of the umbilicus. The extraperitoneal operation would seem to be preferable. It causes less disturbance to the patient although it must be done on both sides, and there is not the same danger associated with it. Cases of peritonitis have followed the intraperitoneal operation which would seem to be due to the division of lymphatics coming from the caecum, when perhaps lymphatic glands have been removed in gaining access to the sympathetic cord. These lymphatics are likely to contain organisms coming from the caecum, where there are more present than in any other part of the alimentary canal, and they may enter the peritoneal cavity. In the case of the upper limb the operation that is done for Raynaud's disease is recommended. When there is actual gangrene present amputation must be done where it is judged, from tests, the circulation is sufficient.

Diabetic Gangrene.—In diabetes gangrene is rather apt to appear. It is said that it is due to poor nourishment of the tissues from the deranged metabolism, but is also very largely due to accompanying arteriosclerosis. Perhaps, also, a diabetic neuritis may play its part in producing some trophic change.

Diabetic gangrene may begin in a toe or in a patch on the dorsum of the foot. It may be of the dry or moist type, dependent upon whether there is much arteriosclerosis present.

In the treatment of gangrene of this type it is not always necessary to amputate the limb above the knee joint. Sometimes, when the diabetes is corrected by insulin, the gangrenous part will be shed and the wound will actually heal, but when the vessels are sclerosed and there is loss of pulsation in the dorsalis pedis and the posterior tibial arteries, amputation is nearly always necessary. There is very little risk in operating on a diabetic patient if his disease can be controlled by the use of insulin.

Spastic Gangrene.—The commonest example of this is that which is due to Raynaud's disease. Raynaud's disease is one which affects young people and women more than men. Whilst it is seen in the lower limb it is much more commonly observed affecting the hands. In response to some external stimulus, usually cold, the vessels of the extremity go into spasm which causes the fingers to become pale and bloodless. This stage is liable to be followed by one of cyanosis, the colour changing to blue, mottled with red. Cyanosis may go on to actual stasis and gangrene, the gangrene being usually superficial in type and affecting the extremities of the fingers. In very bad

Burns and Scalds.—Burns are due to the application of dry heat, scalds to the application of moist heat. There are several degrees of burn. In the first there is a mere scorching of the surface epithelium which leaves a whitish area on the skin. In the second blistering occurs. In the third the superficial part of the true skin is destroyed, but the deep parts of the sebaceous and sweat glands remain and the interpapillary processes with their nerve endings. In the fourth degree the whole thickness of the skin down to the subcutaneous tissue is destroyed. In the fifth degree burning destroys muscles, and in the sixth degree the whole of the limb, including the bones, is charred.

The initial symptoms of burns are due to shock and collapse. There are a low temperature, rapid feeble pulse, shallow respiration. This shock and collapse are particularly pronounced in a burn of the third degree which has exposed the sensitive nerve endings of the skin and in which the pain is very severe. The shock may continue into prolonged collapse (secondary shock) and toxaemia which is due to absorption from the disintegrated burnt proteins in the tissues. As a rule, however, the shock passes off in some degree and a state of reaction occurs. The temperature is raised, the pulse becomes stronger and these symptoms of reaction persist.

In the toxaemic stage, which begins as a rule between the 12th and 24th hour, besides the general symptoms of raised temperature, there is evidence of inflammation of the internal organs. Congestion of the meninges leads to headaches, perhaps to delirium, congestion of the lungs and pleura to bronchial pneumonia. In the abdomen, the inflammatory reaction may be evident by vomiting and diarrhoea. The liver and spleen are often enlarged, the kidneys are congested, leading to albuminuria. A rather rare complication is the formation of an ulcer in the duodenum, Curling's ulcer, which actually may perforate into the peritoneum. There is a great loss of fluid which is exuded partly on to the surface and partly into the tissues as oedema, so that the blood becomes concentrated and there is a polycythaemia, from 125 to 140 per cent. At the same time there is some destruction of the red corpuscles which is shown by a haemoglobinuria. The gravity of the burn depends ultimately upon its surface extent. The patient does not usually survive if one-third of the area of the body surface is burnt, and certainly dies if the affected area amounts to one-half. Burns on the trunk and head are more serious than burns of the extremity; and burns of the third degree, where the sensitive nerve endings are exposed, are more serious than deeper burns. The patient may die from shock, from later toxaemia or finally from the results of sepsis.

In the treatment of burns it is essential in the first place to combat

that the vessels of the limbs are supplied not only with vasoconstrictor fibres but with vasodilator fibres, which are also severed in the operation, whilst it is also thought that some local mechanism plays an important part in the production of the spasmodic attacks characteristic of the disease. An attempt to divide the constrictors alone leaving the dilators intact has been done by dividing the trunk of the sympathetic cord below the third thoracic ganglion, and the rami communicantes between the second and third thoracic nerves and the cord. The results of this operation are claimed to be more permanent, but it does not seem that this claim can be substantiated. When lumbar sympathectomy is done for spasmodic arterial disease in the lower limbs, the results are much more likely to be permanent than in the case of the upper limbs. It is said that this is explainable because there are more abundant constrictor nerves going to the legs than to the arms, but the operation is one in which the afferent nerves to the local ganglia are divided alone and is analogous to the operation on the upper limb in which the stellate ganglion is left intact.

Spasmodic arterial gangrene may result from ergot poisoning. The condition is almost unknown in this country. It is seen more commonly in countries such as Russia where rye bread is eaten, the parasite having attacked the grain which is being used.

Traumatic Gangrene

Traumatic gangrene is the term given to death which follows directly on some injury. If a limb is crushed between two large objects and dies, this is direct traumatic gangrene.

Indirect gangrene results from injury to an artery. In an accident a main artery may be torn across or it may be divided in an open wound, or may perhaps be ligatured. When traumatic gangrene is present, amputation is required.

In the case of direct traumatic gangrene it had better be done immediately, but when the gangrene is indirect the formation of a line of demarcation had better be awaited. Meanwhile the limb should be wrapped in aseptic dressings, kept warm and raised on a pillow to facilitate the return of blood. When the injury has occurred in a healthy limb the amputation can be done immediately above the line of demarcation.

Physical and Chemical Gangrene

Gangrene under this heading includes frost-bite, burns, that due to electrical currents, to exposure to radiation, or to the application of strong chemicals.

The danger from electrical shocks is that of death from cardiac inhibition and respiratory failure. The primary treatment, therefore, is in nearly every case artificial respiration. The treatment of the gangrene is to protect the injured parts from infection by covering them with an aseptic dressing. Amputation will probably be required in the case of the limbs and can be done immediately above the line of demarcation.

Frost-Bite.—Frost-bite affects the extremities of the fingers, toes or the tips of the ears and nose. When it appears it is usually more obvious to other people than the victim himself as it is quite painless. The part becomes white in colour.

In the treatment the greatest care must be taken not to thaw the tissues too quickly, otherwise a strong hyperaemic reaction will occur which will increase the area of necrosis. The circulation should be restored by first rubbing the parts with snow, then warming them by the heat of the hands, and very gradually bringing the patient into a warmer atmosphere. A line of demarcation will appear in the usual way and an amputation will perhaps be necessary.

Gangrene due to Chemicals is sometimes met with in practice. The most important one to be on guard against is that due to carbolic acid. If a dressing containing carbolic acid be applied to a finger surrounded by an impervious covering, gangrene of a dry type will follow. The same phenomena are seen with lysol dressings and there is some risk with alcohol. So that it is extremely important never to use a carbolic or lysol dressing for a finger.

Infective Gangrene

Infective gangrene is due to the activity of organisms which secrete toxins of such potency that they cause massive destruction of the tissues.

Gas Gangrene is a clinical condition which sometimes follows infections of wounds. It is of a very serious nature, as it spreads very rapidly and may lead to the death of the patient within thirty hours. It is a complication of war wounds and those sustained in civil accidents which have been contaminated with soil.

The first sign is increased pain in the neighbourhood of the wound and great tension of the tissues. The temperature is raised in the early stages but, when there is very severe toxaemia, it may be subnormal. As the infection advances the patient becomes anxious and alert and the skin muddy in colour. The surface of an open wound infected with gas gangrene is almost dry, but in the scanty thin exudate gas bubbles may be seen. Should the wound be of a penetrating

the actual shock. This must be done by relieving the pain with morphia or opium, giving warm drinks and applying warmth to the body, which can very conveniently be done by a bed cradle from which are slung electric lamps. Plasma or serum are indicated for shock. Because of the oligaemia the administration of liquid is extremely important. It has been estimated that if the haemoglobin in the blood rises to 140 per cent the patient will die. Large drinks of M/6 sodium lactate (2 per cent) should be given. By this route it is much more effective than intravenously. It is suggested that its passage through the portal circulation leads to liver proteins passing into the blood.

Locally the immediate object should be the protection of the burned area from further trauma and infection. A sterile dressing of gauze and wool will suffice, or if this is not available, clean laundered linen must be substituted. A dressing which will not stick is better and a sulphathiazol ointment is good for the purpose. (Lanette wax SX 30 parts, glycerin 7 parts, chlorcresol 0·1 part, sulphathiazol 5 parts, sterile distilled water to 100 parts, sterilised by autoclaving at 10 lbs. for 30 minutes.) It has been demonstrated experimentally that the old-fashioned carron oil (linseed oil and lime water in equal parts) is quite favourable to healing. As soon as the condition of the patient allows, a careful cleansing of the burned area is carried out, often under anaesthesia. The neighbouring skin is cleaned with cetavlon solution, blisters pricked and burnt skin cut away. All dust is carefully removed from the burnt surface, and the thiazol ointment, to which has been added penicillin, applied on gauze. Pressure, which will limit the amount of exudation, is obtained by bandaging over thick layers of wool. A splint to keep the part at rest is often desirable. The dressing is not touched for 10 to 14 days. Then it is removed and a new dressing applied or the granulating surface grafted. When the flexor surfaces of the limbs are extensively burnt, contractions are very liable to occur as the result of the cicatrising process. They can be avoided by splinting the joints in the extended position. In the case of the fingers where the capsules of the joints are so near the surface, early movements are essential if the fingers are not to become fixed. Active movements in a warm saline bath are helpful. In all cases the amount of fibrous tissue which forms is less the earlier skin grafting is done.

Gangrene from Electrical Causes.—The gangrene which results from the passage of electrical currents in the body is a peculiar type in that the reaction of the tissues around is very slight and may be delayed for a long time. Ultimately the dry, shrivelled-up, dead tissue is removed and more tissue is preserved than at first sight seems probable.

impaired blood-supply. Foreign bodies must be removed. The large vessels and all the nerves must of course be preserved. The deeper structures of the wound should not be sutured with catgut, nor indeed with any other material; the wound had better be left freely open. Powdered penicillin and sulphathiazol scattered over the surface of the wound inhibits the growth of the bacteria. A light vaseline pack should be left in the wound. The tissues must be immobilised in splints, and very often plaster of Paris is the most suitable material for this purpose.

When gas gangrene is thought likely to supervene, sulphadiazine should be given prophylactically. The first dose is 1·5 gm. dissolved in hot 1 per cent citric acid solution in order to get rapid absorption; in 2 hours' time another ½ gm. is given, and beginning from this, ½ gm. doses are administered every 4 hours for 4 days. Polyvalent serum against the three principal anaerobes can also be given as a preventive measure; a dose is 3000 International units *Cl. Welchii*, 1500 I.U. *Cl. septicum* and 1000 I.U. *Cl. oedematiens* anti-toxins. It is given intravenously or intramuscularly. When the disease is present the dose of sulphanilamide, or in this case preferably sulphapyridine, should be greater, the first dose being 2 gm. and the subsequent doses being of 1 gm. At the end of 4 days the dosage should be reduced. Polyvalent serum again should be administered as it has been found experimentally that serum and sulphanilamide have a synergic action. Experimentally penicillin is far superior to the sulphonamides. It should therefore be given. No effective antitoxin against the *Clostridium histolyticum* has been developed. Infection with this organism is invariably fatal.

If the disease continues to spread in spite of treatment, amputation will be necessary. When this decision has been reached, a tourniquet may be put round the limb at the site of the proposed incision because it is found that, although the infection may spread rapidly up to this level, it will not transgress it. In all amputations for gas gangrene the flaps are left widely open.

As there is always acidosis, alkalis should be given by mouth and perhaps intravenously; 2 per cent sodium lactate may be given through both these channels.

Cancrum Oris is a rare form of gangrene seen in the mouths of weakly children. It only occurs under conditions of destitution and in squalid surroundings, or when the health has been very greatly depressed by a bad attack of one of the exanthemata. There are always septic teeth in the mouth. It begins as a small septic ulcer on the inner side of the cheek, from which the gangrenous process spreads rather quickly to the gums, the floor of the mouth, perhaps

type, there is very great swelling of the limb and perhaps crepitation due to gas in the tissues. The skin is of a dirty brown colour with a marbling of the surface from stasis in the subcutaneous veins. Purple patches appear and finally greenish areas. There are characteristic changes in the muscles, which become brick-red in colour, lose their contractility on mechanical stimulation and do not bleed when cut. Gas bubbles are found between the fibres. Later the brick-red colour changes to green or greenish black. The gas bubbles can be demonstrated by X-rays. The process spreads very rapidly up the limb and invades the trunk. The patient dies from heart failure due to the profound toxaemia.

The microbes responsible for this condition are all anaerobes: they are, in order of frequency, the *Clostridium Welchii*, the *Clostridium septicum*, *Clostridium oedematiens* and *Clostridium histolyticum*. As a rule the infection is a mixed one but sometimes the *Cl. Welchii* is present alone. The ordinary pyogenic organisms are commonly associated with the infection.

Many wounds become contaminated with these anaerobic microbes without gas gangrene arising, so that their demonstration bacteriologically does not mean that the patient is suffering from gas gangrene. The factors which lead to an invasion of the tissues are not accurately known, but the infection is favoured by the presence of dead tissue, by the interference of the blood-supply, by the presence of foreign bodies or the action of injurious chemicals or toxins of aerobic pathogenic bacteria. The use of a tourniquet in a limb with a contaminated wound is likely to favour the onset of gas gangrene.

The treatment of gas gangrene must be undertaken without delay. The onset of the infection can often be prevented by the débridement of wounds. When, however, there is a through-and-through wound and no evidence of constitutional disturbance the track need not be opened, only the paths of entry and emergence being excised.

When actual infection has taken place it is essential that the fullest drainage should be provided. The wound is very widely opened and affected muscle tissue excised because microbes grow more easily in muscle tissue owing to the production of lactic acid when the muscle dies, which favours their germination. In excising wounds very little skin need be removed, not more than a few millimetres, but the skin wound may need to be very freely enlarged in order to get sufficient exposure of the deeper structures. Such incisions are made parallel with the axis of the limb. Bruised tags of fascia or muscles are cut away. Blood clot must be removed and the deep fascia freely divided to allow of muscle-swelling should

CHAPTER XII

DISEASES OF THE SCALP

INJURIES

Wounds of the Scalp caused by sharp instruments or glass may lead to serious haemorrhage but this is easily controlled by sutures. The arteries lie in dense fibrous tissue close under the skin and are difficult to ligate. If the wound penetrates the epicranial aponeurosis and sepsis is introduced there may follow widespread suppuration. The pus collects in the space beneath the aponeurosis and is limited in front by the origin of the frontalis muscles, at the back by the origin of the occipitalis muscles and at the sides by the attachment of the aponeurosis to the temporal fascia. The whole of the aponeurotic area may be raised by the inflammatory exudate so that the skull is surmounted by a kind of fluid cushion containing pus. The collection must be evacuated by incisions which are made in the temporal regions in the most dependent part. Such suppuration is extremely dangerous because it is liable to cause thrombosis of diploic veins which penetrate the skull and reach the superior longitudinal sinus, the septic thrombosis of which is a fatal disease.

Sometimes in accidents the hair is caught in machinery and the scalp is avulsed, perhaps leaving the whole of the vertex of the skull bare. Even in such extensive accidents it is often possible to replace the scalp with some prospect of its retaining its vitality. It is so vascular that a comparatively narrow pedicle will convey enough blood to preserve its life. Before replacing the scalp the utmost care must be taken to render the wound as clean, surgically, as is possible. When the scalp has been completely separated, or if it should die, it will be necessary to treat the bare skull as an ordinary surgical wound until granulations have covered its surface. It is then possible, in separate stages, to graft the area. The patient will have to wear a wig.

A *Haematoma of the Scalp* results from blunt injuries which do not break the skin. Small haematomata occur in the superficial tissues.

even the soft palate and the tonsils. There is a most dreadful smelling discharge which the patient swallows. His breath is very foul. The process not only spreads superficially but may extend to the surface of the cheek, with the result that, finally, a slough having separated, a large hole may remain communicating with the mouth. The outlook in this disease is very serious; the patients so very often die from exhaustion or bronchial pneumonia. The organisms found are streptococci with spirilla and fusiform bacilli, such as occur in Vincent's angina.

There is only one way of checking the disease and that is by the use of a diathermy cautery to destroy the infected tissues. Or, if a cautery is not available, the disease may be scraped away and the raw surface painted with pure carbolic acid which must be neutralised afterwards by the application of alcohol. The resulting disfigurement left may need an extensive plastic operation for its cure. Penicillin and sulphadiazine should of course be administered.

Noma Pudendi is a somewhat similar gangrenous process which affects the vulva in female children under similar circumstances.

curd of milk. There may be an aperture in the skull underlying a dermoid cyst which may thus actually be adherent to the dura mater.

Angiomata.—A particular form of angioma occurs characteristically in the scalp. It is found usually in the temporal but sometimes in the occipital region and is called a cirsoid aneurysm, or plexiform angioma.

The tumour usually develops in early adult life and may reach a considerable size, extending to the external ear and down the neck. It consists of a large collection of tortuous pulsating vessels. Over it a loud bruit can be heard which is sometimes also perceptible to the patient. In reality, a plexiform angioma consists of dilated veins as well as dilated arteries, and there are communications between the two systems of vessels, so that there are multiple arteriovenous aneurysms present. At the periphery very much hypertrophied branches of the temporal and occipital arteries can be seen running into the mass. The condition is an extremely dangerous one on which to operate because the haemorrhage may be very severe and difficult to control.

One successful method has been to operate in two stages. In the first stage, with a tourniquet round the skull, a circular or curved incision is made round the growth down to the sub-aponeurotic space, the flap outlined and the epicranial aponeurosis, containing the vascular mass, turned down. Divided vessels in the periphery of the incision, which have been partly controlled by digital compression, and vessels which have come through the skull and penetrated the mass, are ligated and so are the cut vessels in the edge of the flap. Several layers of gauze are then placed in contact with the skull, the flap replaced, and the whole bandaged and left for four days. At the end of this time the flap is again turned down when it will be found that most of the vessels have thrombosed. The epicranial aponeurosis, including the vascular mass, can then be removed in one piece from the subcutaneous fascia.



Large very vascular sarcoma of scalp.

Plexiform Neuroma.—This is a tumour composed of soft connective tissue which contains numerous branching nerves, and is very vascular. A thickened network of nerves can be felt very easily through the skin lying in the very soft connective tissue. The tumour is usually noticed first in children. Some care in the removal of such tumours is necessary because of the great vascularity.

Sarcoma sometimes grows from fibrous tissue in the scalp.

Bleeding may also take place beneath the epicranial aponeurosis when a very large fluctuating swelling forms which droops down over the eyes, in front, and the ears, at the side. Such a haematoma should be aspirated with a needle and pressure applied to the head.

In association with fractures of the skull haematomata form under the pericranium. Such haematomata are sometimes difficult to distinguish from depressed fractures of the skull, because the surface shelves gradually into the surface of the surrounding bones. The centre consists of serum which is exuded from the peripheral clotted portion. The finger, therefore, pressed down into the centre of the swelling reaches the bone underneath and, as it moves to the periphery, encounters the abrupt edge of the peripheral clot which simulates very strikingly the fractured edge of bone covered by a bruised scalp. The distinction can usually be made clear by noting that the edge is really raised above the general skull level.

Tumours of the Scalp

Papillomata.—These are warts, usually small, which grow on the scalp. They require nothing but removal.

Sebaceous Cysts are the commonest tumours which occur in the scalp. They are very frequently multiple and may form large soft lumps (wens) which are adherent to the skin and fluctuate. Sebaceous cysts are very easily removed. This operation should be done because two complications may occur: sepsis and transformation into a malignant growth. Suppurating sebaceous cysts form abscesses which must be opened and the abscess allowed to heal. The cyst wall should be dissected out in a few weeks' time when all signs of infection will have disappeared. A suppurating sebaceous cyst which has remained for a long time, with an opening on the surface, may ultimately be transformed into a carcinoma (Cock's peculiar tumour). Wide removal is required for these growths.

Lipomata occur in the scalp, usually under the epicranial aponeurosis where they form soft fluctuating swellings not adherent to the skin. The common site is under that part of the epicranial aponeurosis which covers the frontal bone. A lipoma which has been present for a long time may be surrounded by a palpable ridge of bone. Their removal is easily carried out.

Dermoid Cysts occur in the middle line of the scalp and forehead. They are rounded swellings, not attached to the skin, which fluctuate. They do not become tense when the child cries or coughs. Sometimes they are translucent, for, when opened, there will be found in them clear fluid containing at one side some cheesy material, like the

curd of milk. There may be an aperture in the skull underlying a dermoid cyst which may thus actually be adherent to the dura mater.

Angiomata.—A particular form of angioma occurs characteristically in the scalp. It is found usually in the temporal but sometimes in the occipital region and is called a cirsoid aneurysm, or plexiform angioma.

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CHAPTER XIII

OXYCEPHALY, HYDROCEPHALUS AND ENCEPHALOCELES

Oxycephaly

In this curious condition, called tower skull, the head assumes a peculiar conical shape, the summit rising up to a peak. Associated with this are a gradually increasing blindness due to optic atrophy, and some exophthalmos. Headache is a prominent symptom, but there is little or no mental impairment. The immediate cause is a premature synostosis of the coronal and sagittal sutures, but why the frontal and parietal bones should join up in this way nobody knows. The anterior fontanelle remains open and through this the compressed brain bulges, giving the characteristic form to the skull during the process. The blindness is due to the long-continued slight increase in intracranial pressure leading to optic atrophy.

The convolutions of the brain squeezed against the inner face of the skull leave their impressions there which are visible in an X-ray photograph.

The only logical treatment is to perform a bilateral temporal decompression. This has done good in some cases and the sight has been saved.

Hydrocephalus

This is a condition which results from an inflammatory interference with the absorption of cerebrospinal fluid. The chronic inflammatory changes in the leptomeninges result from meningitis, subarachnoid haemorrhage or sinus thrombosis. When the cicatricial process is around the fourth ventricle, blockage of the foramina of Magendie and Luschka takes place. This leads to an internal hydrocephalus. In some mild types of sinus thrombosis the arachnoid villi are obstructed. This causes an external hydrocephalus.

Chronic Progressive External Hydrocephalus

Chronic progressive external hydrocephalus occurs chiefly in adults in whom there is a history of an infection or injury. There are signs of increasing intracranial pressure with the usual papilloedema and abducent nerve paralysis. There are no localising symptoms. Ventriculography demonstrates the lesion, for there is no distension or distortion of the ventricles, while there is increased space between the brain and the skull.

A right subtemporal decompression allows the excess of fluid to pass into the scalp and be absorbed and may cure the patient. In the worst cases a second decompression on the left side may prove necessary.

Chronic Progressive Internal Hydrocephalus

In chronic progressive internal hydrocephalus the patient is usually a child who may have been born with the abnormality or have acquired it. The commonest cause of the latter is closure of the foramina of Luschka and Magendie as the result of cerebrospinal meningitis, but a tumour in this region may similarly give rise to obstruction. Some observers believe that the congenital form also has an inflammatory origin, but others attribute it to a disturbance of the relation between the secretion and absorption of cerebrospinal fluid. The appearance of the child is very characteristic. The brain case overlaps the tiny face in front and behind and is very much larger than normal. The fontanelles and sutures are widely open. There are large veins on the scalp and the hair is apt to be scanty. The eyes look pushed downwards. The disease is usually progressive, the head gradually gets larger, the mental powers deteriorate; the child becomes paralysed if it has ever learned to walk, it may have fits, becomes blind and dies The dilatation of the ventricles can be demonstrated by ventriculography.

Many operations have been devised in the attempt to cure the congenital condition. The results are bad.

In the acquired form the region of the fourth ventricle should be explored. It may be possible to separate adhesions and free the foramina. In the case of a tumour, if it should prove to be a medulloblastoma (page 146) it should be left alone as it is simply not worth taking it away, but if a gliomatous cyst be found it should be removed together with its intramural nodule.

Encephaloceles

These are congenital protrusions of the contents of the skull and occur at the glabella, the inner side of the orbit, the occipital region, or occasionally at the base of the skull. The swelling contains (1) brain with an offshoot of the lateral ventricle and covered by the arachnoid—hydrencephalocele, (2) brain tissue alone—encephalocele or (3) cerebrospinal fluid alone—meningocele. The bone and dura are defective where the protrusion occurs.

The true nature of encephaloceles is not known. A certain degree of hydrocephalus often accompanies the condition. It is supposed that an encephalocele arises from a hydrencephalocele by the brain sinking back into the skull, and the meningocele by the degeneration and disappearance of the brain tissue. The skin over these swellings is usually of normal texture. The meningocele is translucent and, if its connection with the skull has not been cut off (as sometimes happens in the recessive process), it will get tense when the child cries. The other two varieties pulsate or can be made to do so by gentle pressure on them, though this may cause symptoms of compression such as slowed pulse, vomiting or loss of consciousness. Meningoceles may be removed and the opening in the dura sewn up, but not in the presence of a hydrocephalus unless it is perfectly certain that the head is not increasing in size. In operating upon encephaloceles in the frontal or occipital regions portions of the frontal lobe or cerebellum may have to be removed.

CHAPTER XIV

DISEASES OF THE SKULL AND BRAIN

General Considerations

There are certain anatomical and physiological considerations which are of great importance in the surgery of the brain. The extreme delicacy of nervous tissue, its vulnerability, its incapacity for regeneration; the far-reaching disturbances from small injuries, and the tendency to general derangement of functions from localised affections, all render any effective intervention of the gross nature of surgical measures extremely difficult, full of risk and not always possible without producing further irreparable damage to function. The bony encasement which protects this fragile organ, whilst protecting it from the small accidents of ordinary life, becomes an embarrassment when the brain from injury or disease becomes enlarged or when a haemorrhage occurs within the cranial cavity. Though there is some provision for such demand for increased space by the escape of cerebrospinal fluid from the skull into the dural sac of the cord, which lies loosely in the bony canal and so can expand, this accommodating mechanism soon breaks down, and the brain is subjected to undue pressure and a state arises which is called cerebral compression. In most affections of the brain there are symptoms of compression in some degree. They are the general symptoms of intracranial disease. On top of these symptoms are usually others which come from disturbance of the particular part of the brain affected. These are called local symptoms. It is by a study of local symptoms that the surgeon is enabled to determine which area of the brain to expose, a decision of very great importance considering the difficulty of access through the hard bony encasement. He cannot lightly open the skull and examine its contents as he may do in the abdomen, neither can he displace the brain to any great extent without damage if he makes his opening a little to one side of the desired place. Hence very great efforts have been made to analyse symptoms and correlate them with the lesions found on the operating or post-mortem table. Although there are rather extensive silent areas of the brain, where at any rate

the disturbances are slight or too little distinctive to allow of localisation, considerable progress has been made. When an area of the brain is subjected to pressure it is first stimulated so that there are emotional changes, sensations or muscular contractions produced, and then thrown right out of action with the resultant defects of mind, sensation or motor power. The study of the surgery of the brain becomes comprehensible and relatively simple if the physiological functions of the various areas of the brain and the changes brought about by compression be remembered, for in every case the clinical picture is made up of these two elements. A description therefore follows of localising symptoms met with in brain surgery, preceded by those of compression and those of one other general affection, concussion.

Concussion

This is a condition of suspended animation which follows upon a blow on the head. The collapse of the patient is sudden and complete. He lies unconscious and motionless with the pallidity of death. He does not breathe, nor does his heart beat. His pupils are widely dilated. He may, in this state, actually die, but usually he very shortly begins to revive. His heart resumes its beat: he breathes, and returns partly at least to consciousness. This is the common stage in which he is seen. He still lies apparently unconscious with pale face, but he can be aroused by shouting and will often reply, though he relapses again into his apathetic state. His pulse is rapid and weak, his breathing shallow and slow. The pupils in this stage are moderately contracted, equal, and react to light. The knee-jerks are present. The temperature is subnormal. During the primary stage of profound unconsciousness the sphincters relax, so he may have passed a motion or urine involuntarily.

The pathology of concussion is not known. In pure concussion there are no post-mortem changes visible, or at most some minute punctate haemorrhages in the corpus striatum and around the Sylvian aqueduct. Experimentally a blow on the skull has been found to indent it. The sudden diminution in cranial capacity must raise the pressure within the skull, and it has been supposed that it causes a general anaemia of the brain by collapsing the capillaries. It is difficult to see how such sudden ablation of function could be produced by the very short-lived anaemia, especially as the elastic recoil of the indented skull must suck the blood back into the brain. Moreover in experiments it has been found that complete anaemia of the head by ligation of the aorta does not act in this way. Seven or eight respirations happen before stoppage and the bl

concussion there is immediate stoppage of the heart and respiration. The injection of thorotrast into the carotid artery deprives a large area of the capillary bed of blood for about one second, but there is no loss of function of the part involved. It has also been supposed that the indenting skull causes a wave of cerebrospinal fluid to pass out of the lateral ventricles into the third and so through the aqueduct into the bulb. The impinging wave is held to paralyse the respiratory centre and cause stoppage of the heart by stimulation of the vagus centre. A newer conception is that the wave causes displacement of the cerebrum in relation to the tentorium, so leading to deformity and stretching of the connections of the hemispheres with the brain stem, and direct injury to the thalamus in which consciousness is supposed to be centred. There was an old view that concussion was due to a mechanical shaking-up of the brain, what was called commotio cerebri, and there has been a tendency to return to this conception. For bacterial cultures have been killed by mechanical agitation and vibration has also been shown to cause physico-chemical changes in colloids. The actual metabolism in the nerve cells may be disturbed by mechanical alteration of the mutual relation of the more solid particles and granules within the fluid protoplasmic basis. Whatever may be the truth, in pure concussion there are few, if any, signs of structural damage to the brain and the patient recovers completely but always with a loss of memory of the accident and the events immediately preceding it. Recovery is often accompanied by vomiting. The volume of the pulse improves, colour returns and the temperature rises. The patient may pass through a stage of what is called cerebral irritation in which he characteristically lies curled up on his side resenting any interference, often becoming violent. After a bad concussion recovery may not be absolutely complete. Memory may be impaired, or capacity for work or concentration lowered, or there may be headaches, neurasthenia or slight deterioration of character. All these things, however, probably arise only when there has been in addition to the pure concussion some contusion of the brain substance or small lacerations, in which case there will almost certainly have been some evidence of superadded compression. A concussed patient can never remember the actual accident nor the events which immediately preceded it. Sometimes he cannot recall what happened during several days before.

Cerebral Compression

There is a great contrast between the pale deathly appearance of the concussed patient and one suffering from compression. It is

discernible at a glance. The cerebrally compressed patient lies with a flushed bloated face of dusky hue. When pressure within the skull rises, the veins in which the blood-pressure is lowest are the first to become partly closed. The venous blood is forced out of them through the communicating diploic and other veins such as the ophthalmic into those of the scalp and face. The conjunctivae are suffused, the eyelids oedematous and the eyeballs bulging. The increased resistance to the cerebral circulation stimulates the blood-pressure to rise, the heart beats more forcibly and slower. So that a full, bounding slow pulse is characteristic. The respirations are slow, deep and sometimes stertorous because of the flapping of the paralysed soft palate. The temperature is raised a little. If one side is paralysed the temperature may be a degree higher than on the other side. With an ophthalmoscope the retinal veins are seen to be dilated, whilst there is blurring of the nasal side of the optic disc or a frank papilloedema. Although fluid surrounds the brain and percolates its substance, the pressure throughout the cranial cavity is not usually uniform owing to the brain being pushed close up against the falx cerebri or tentorium and

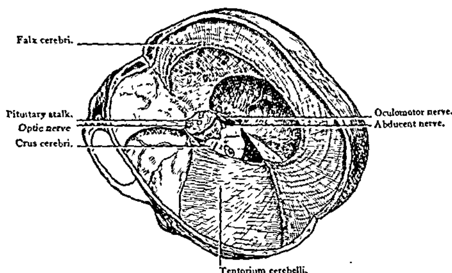


Diagram to show how the cranial cavity is subdivided into compartments and the relation of the brain stem to the incisura tentorii.

so virtually separating the space into pressure-isolated cavities. A tumour or a haemorrhage or oedema of the cerebrum will press the brain stem downwards through the opening in the tentorium cerebelli. The sixth nerve, which runs upwards and forwards from the lower border of the pons to its aperture of exit in the dura, is stretched by this downward displacement. Hence internal squint is very common. As the thrust is usually oblique and there is more oedema on one side, frequently only one sixth nerve is affected. When the lesion is on one side and particularly when it is in the temporal lobe th art of

this lobe which lies against the crura cerebri, that is the hippocampal and uncinate gyri are wedged into the tentorial aperture. Thus is caused a local compression of the brain stem. The signs of this are rigidity of the limbs and trunk in extension, hyperthermia and hyperpnoea. Because of the pressure on the uncinate gyrus there

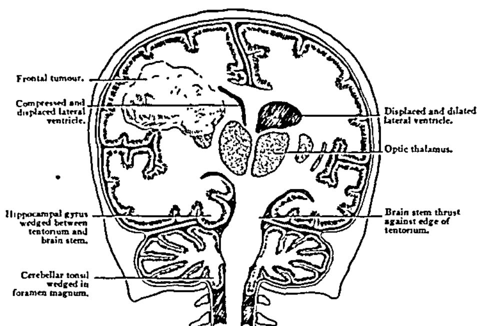


Diagram of displacement and compression of brain caused by a supratentorial tumour.

may be hallucinations of taste and smell. The downwardly projecting temporal lobe is apt to catch the oculomotor nerve, stretch it, and cause the pupil on the same side to be dilated and fixed.

Pressure is greatest in the neighbourhood of a localised lesion. As one is nearly always present when there is compression, asymmetrical localising signs can be detected. Thus the pupils, which have lost their power of reacting to light, are unequal (first constricted, then dilated on the side of greater pressure, the same changes occurring later on the opposite side), one or other limb is paralysed, or one side of the face or one or other cranial nerve. The knee-jerks and other deep reflexes in the paralysed limb are exaggerated, for the paralysis is of the spastic type. Similarly the plantar reflex is extensor. Before paralysis comes on there usually occur twitchings or actual convulsions, or there are very frequently great irritability and a throwing-about of the body and limbs. As the pressure increases a stage will occur when it will be transmitted to the bulb, which with the cerebellar tonsils are forced down into the foramen magnum. Then a change occurs. No longer are the vasomotor and vagal centres stimulated. They become paralysed in their turn. The pulse now becomes

rapid and small, the breathing remains stertorous but the temperature rises very considerably, even to 107° or 108° F. This is a very dangerous stage. No patient survives it. It is too late for any surgical operation to be effective. Both pupils are widely dilated, all the limbs are paralysed, both cheeks are blown in and out by

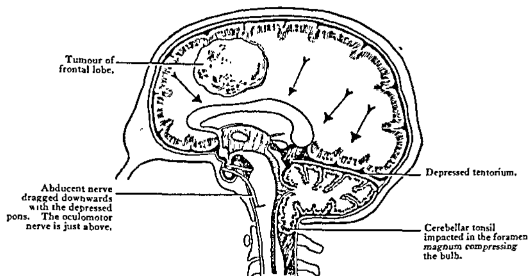


Diagram to show the downward displacement of the base of the brain when pressure in the upper cranial chamber is increased. The third nerve is also frequently stretched by the bulging downwards of the hippocampal gyrus.

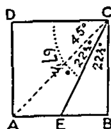
respiration. The breathing may become of the Cheyne Stokes type and then stop. The patient dies with the subsequent cessation of heart-beat.

When, owing to the slowness of evolution of a pathological process, the intracranial pressure is only very gradually raised, headache, vomiting, optic papilloedema, a drowsiness so that the patient is very apt to fall asleep, and changes in mental ability and character which will be referred to later (page 124), are constant symptoms. Owing to the inability of the cerebral circulation to adjust itself quickly, the patient may suffer from transient giddiness or transient amblyopia, or both, on suddenly rising from the recumbent position. The diplopia from stretching of the sixth nerve is often intermittent. In an X-ray there will be seen decalcification of the posterior clinoid process. Such slow compression is found in intracranial tumours, abscesses of slow growth and chronic subdural haemorrhage.

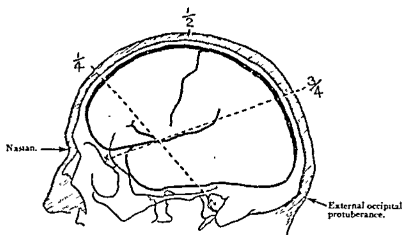
Localisation of Function in the Brain

Cerebral Hemispheres.—On page 124 is the well-known physiological chart of the better known and more easily recognised areas associated with the different functions. A few anatomical facts should

be borne in mind and may be recalled by reference to the figure. The approximate sites of the two important fissures, that of Rolando and that of Sylvius, are easily remembered. The fissure of Roland begins above, one half-inch behind the midway point from the root of the nose to the external occipital protuberance. From here it runs downwards and forwards, making an angle of 67½° with the midline. This angle is very easily obtained. Take a square of paper and fold it along its diagonal AC. This gives an angle of 45°, ACB. Now fold the paper over again, thus halving this angle and obtaining one of 22½°, BCE. The complement of this angle DCE is thus 67½°. So that if the side of a triangle DC is placed along the midline with D in front, the side CE will correspond with the Rolandic fissure. The fissure extends downwards to the level of the fissure of Sylvius,



which is marked out on the surface by joining the external angular process to a point three-quarters of the way from the root of the nose to the external occipital protuberance. The frontal lobe falls short of



the brows by the thickness of the frontal sinuses, the temporal pole lies behind the level of the ascending process of the malar bone as shown in the diagram, and the attachment of the tentorium corresponds with a line joining the external occipital process with the base of the mastoid process running in part of its course along the superior curved line of the occipital bone. The cerebellum lies below this line.

Again it must be emphasised that symptoms of a localised lesion of the brain may be those caused by stimulation of the area or later of those caused by its destruction, and that at the same time there are usually symptoms of compression.

Frontal Lobe.—The patient first shows faults of omission, an inactivity, an indifference. He becomes solitary and forgetful. He

is unable to give his attention to things. His judgement fails and there may be social lapses. His general demeanour and character have obviously changed, and in the direction of deterioration. He becomes emotional. Curiously enough, although he is mentally dulled he is apt to make witty remarks and exhibits a childish delight in doing so. He is untidy in his habits and erratic. In the end he becomes imbecile. If the lesion extends back to the motor area there will occur fits of Jacksonian epilepsy where the convulsions begin in the part of the body supplied by the area affected but spread generally to the rest of the muscular system. During these convulsions consciousness is not lost at the very beginning as it is in idiopathic epilepsy. The site of origin of the convulsions is therefore of very great importance for localisation (see figure). In front of the lower part of the

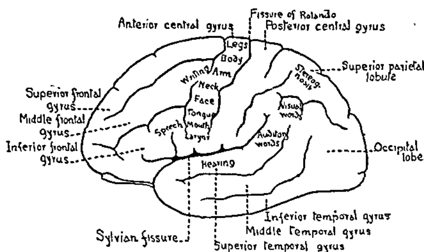


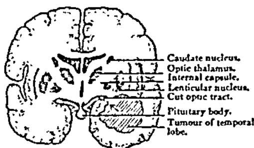
Diagram of cerebral localisation.

precentral gyrus a lesion may cause conjugate deviation of the head and eyes to the opposite side at the beginning of a fit. The fits are associated with weakness or paralysis of the spastic type of the same muscles. There will be exaggerated knee-jerks and an extensor plantar reflex if the leg area is involved. It must not be forgotten that movements not individual muscles are represented in the cerebral cortex. When the tumour is high up in the posterior part of the superior frontal convolution a phenomenon called forced grasping and groping is seen. An object put into the palm of the hand is forcibly grasped and the patient is unable for some time to relax his grip. He will grope for the handle of a door and find himself unable to let it go. On the left side of the inferior frontal convolution is the motor centre for speech. When destroyed there is motor aphasia (apraxia or agraphia).

It has been stated above that symptoms of compression are nearly always associated with localising symptoms. It has also been stated

that compression by itself causes a dulness, drowsiness and apathy. This mental disturbance may very well be confusing in the diagnosis of a lesion in the frontal lobe, the seat of intellectual processes. In general compression they are, however, only inhibited, at least at first; there is no actual abolition of them. This may be demonstrated by giving the patient 45 c.c. of saturated $MgSO_4$ by mouth. This will lower the intracranial tension by being absorbed into the blood-stream and extracting fluid from the brain by osmosis. If there is compression alone the patient becomes intellectually very much more alert. Fixed symptoms which remain can then be more certainly ascribed to an actual local lesion.

One other confusing symptom sometimes occurs in frontal lesions, namely, nystagmus, a phenomenon characteristic of cerebellar affections. The nystagmus in frontal lobe affections is not so sustained as in the case of the cerebellum.



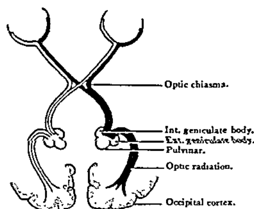


Diagram to show how a temporal tumour causes visual symptoms by pressing upon the optic tract or the optic radiations in the posterior part of the internal capsule. The lower figure shows the connections of the retinae with the visual cortex in the occipital lobe.

Temporal Lobe.—Here there is often a general convulsion at the beginning. Then occur attacks when the patient goes into a peculiar dreamy state. Although the auditory centres lie in the temporal lobe there are not often auditory hallucinations and auditory acuity is frequently unaffected. From the figure it can be seen how closely the optic radiations are related to the temporal lobe, an enlargement of which may press upon them. Thus arises a very important localising symptom—homonymous hemianopia (loss of corresponding halves of the visual fields). How this loss of the opposite side of the visual field comes about is easily understandable by reference to the diagram of the course of the optic fibres from the retinae. At the very beginning only a quadrant of the field is lost. It extends later to the half (cp. occipital lobe symptoms). There may be hallucinations of vision in the blind areas. Images of people and things appear to the patient. There are also hallucinations of taste and smell due to extension forwards

to the uncinate gyrus. Should the lesion increase much in size it may press upon the lower part of the frontal lobe, causing facial weakness of the opposite side, weakness of the opposite arm or even leg with Babinski's sign and absent abdominal reflexes. The third nerve on the same side may be paralysed. Should the pressure extend posteriorly and upwards to the left parietal lobe, the supramarginal and angular gyri, sensory aphasia will occur (anomia—inability to assign names to objects: and inability to understand the written or spoken word).

Parietal Lobe.—This part of the brain is concerned with sensation, hence there is some lowering of sensation on the opposite side of the body, but more characteristic is the loss of sense of position, and the appreciation of two points close together is much less acute, that is, the points have to be further apart than normal for the patient to be able to distinguish them as two separate objects. Allied to these phenomena is the inability to recognise the shapes of objects when felt (astereognosis). With lesions of the lower part of the parietal lobe there are anomia (inability to name objects) and alexia (inability to understand writing).

Occipital Lobe.—There is blindness of both eyes to the opposite field of vision (homonymous hemianopia). Whilst in the temporal lobes the defect of vision may have a quadrantal distribution, in lesions of the occipital lobe the whole of the half-visual field is always affected. Epileptic fits may begin with a visual hallucination. The lesion may extend forwards and encroach upon the parietal lobe, causing aphasia, especially visual aphasia, that is, when it is on the left side.

Mid Brain

Hypothalamus.—Affections of this part of the brain cause sleepiness, polyuria, fever, hyperthermia, hyperpnoea, tachycardia, adiposity and emotional changes, so that the patient is liable to outbreaks of temper.

Hypophysis.—A consideration of the functions of this part of the brain will be found in the section on pituitary tumours.

Cerebellum

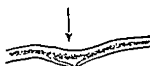
In lesions of the cerebellum the general symptoms of headache, vomiting and optic papilloedema are usually very prominent because so often the intracranial tension is raised above that due to the tumour itself by the obstruction which it causes to the flow of cerebrospinal fluid. In children, indeed, the head enlarges and has a peculiar

hollow sound on percussion. The gait is unsteady and there is a giddiness in which objects seem to rotate towards the normal side. The muscles are weak on the side of the lesion and in the early stages the deep reflexes are diminished. Later, should the pyramidal tracts be pressed upon, the tendon reflexes are exaggerated and there is a Babinski sign present. The neck muscles are stiff. Stiffness of arm muscles on the side of the lesion may be demonstrated by asking the patient to pronate and supinate the forearm quickly, when he will be found unable to do this. There is weak movement of the eyes to the lesion side (conjugate deviation) and a sustained nystagmus when this is attempted. Tonic cerebellar fits in which there are head retractions, arching of back, flexion of elbows and rigid extension of the legs are sometimes seen in later stages.

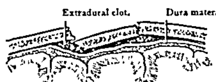
Head Injuries

Fractures of the Skull

Many years ago the elasticity of the skull was demonstrated by experiments in which skulls filled with rather soft wax were dropped on to some hard surface. At the area of contact the skull is pushed



Fracture by bending.



Depressed fracture of skull.

in, forcing some of the wax to escape from its cavity. In the elastic recoil the indented bone springs outward away from the deformed waxy contents. The force may cause the skull to break. Such a fracture produced by a blunt force acting over a limited area is called a fracture by bending. The inner table of the skull is always more comminuted than the outer and may be broken when the outer table shows no injury at all. If a skull be squeezed between two objects it will be deformed, so that the two poles where the forces are applied come nearer together. The equatorial region is subjected to great strain from the increased circumference and gives way, the fractures naturally running along meridians of longitude. Such fractures are said to be fractures by bursting. A depressed fracture is one in which the skull has been forced in beyond the limits of its elasticity so that a part of it remains below the general level of the surface. A fissured fracture is one in which the skull is just split without there being

any displacement. Clinically surgeons speak of fractures of the vault and fractures of the base of the skull. Whilst *this classification* is convenient, it must be remembered that the great majority of fractures of the base extend up into the vault and many fractures of the vault

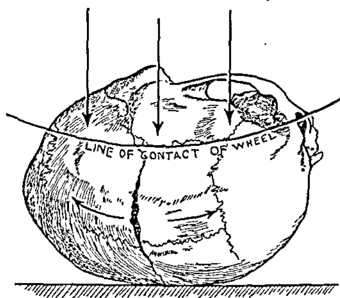


Diagram of a bursting fracture caused by the passage of a motor wheel over the skull.

run down into the base. Fractures of the skull are produced by blows *or falls on the head; or the force may be transmitted to the* base of the skull by the condyles of the lower jaw from a blow on the chin, or the facets of the atlas from a fall on the feet or buttocks. The *principles laid down above as to the general direction of fractures* apply to hollow spheres of uniform thickness. The vault of the skull is of varying thickness, however, and at the base there are massive bony buttresses and bony ridges separated by foramina and clefts at numerous points. This irregularity causes deviations from the simple directions of fractures of uniform spherical bodies.

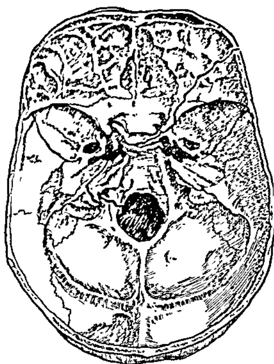
Fractures of the Vault

Fissured fractures without displacement are the commonest, and if the scalp is intact it is scarcely possible to diagnose them without the X-rays. There will be some swelling, discoloration and tenderness along the line of fracture. If the fracture is compound it can be seen as a crack oozing blood. The appearance is quite different from an interlocking jagged suture. Sometimes the crack will have opened up during the impact and imprisoned between its sides some hair or dirt or other foreign body. In a depressed fracture in an adult, the affected area of bone will be felt at a lower level than the surrounding skull and it will be outlined by a sharp edge which i

young children the skull may be indented and remain so whilst the outer table is not fractured. These are called pond fractures. They correspond to greenstick fractures of the long bones. The inner table is frequently splintered. *A haematoma of the scalp may sometimes* closely resemble a depressed fracture, for the blood in it will clot and the clot retract to the circumference. Here it forms a ridge surrounding a depressed area. In such a case it is important to recognise that the edge of the apparently depressed area is really above the general level of the skull. But so great is the diagnostic dilemma that it is sometimes solved only by incision and direct inspection.

Fractures of the Base of the Skull

The middle fossa of the skull is more likely to be broken than any other, but fractures of both anterior and posterior fossae are frequently found in association with it. It is particularly common to find the fracture passing through the petrous portion of the temporal bone and the auditory canal. Fractures of the vault spreading to the base



Fracture of base of skull running from the anterior fossa on one side through the sella turcica to the opposite petrous bone and into the foramen magnum.

have a tendency to run towards the sella turcica. Often a fracture will pass through the middle fossa on one side and forwards across the sphenoid bone to invade the anterior fossa of the opposite side.

When the force is transmitted through the vertebral column the fracture tends to run circularly around the foramen magnum. Fractures of the base are more often than not compound, for they open into the cavity of the nose or pharynx, frontal sinus or middle ear, all of which spaces have a direct connection with the exterior. Thus bleeding from the nose in anterior fossa fractures, bleeding from the mouth in middle and posterior fossae fractures and bleeding from the ear in middle fossae fractures occurs. In the latter case the tympanic membrane must be also ruptured, but this very frequently happens because the tegmen tympani is usually broken. Blood from the nose in anterior fossae fractures may of course pass backwards into the mouth, and in fractures of all three fossae the blood may be swallowed and afterwards vomited. By the same routes cerebrospinal fluid may escape. This is not noticed when it passes into the mouth but is very characteristic when it flows from the nose or ear. It is a colourless clear fluid of low specific gravity and contains a reducing substance. The loss may be very profuse, so much so, that the patient's pillow may be soaked several times a day. This is a compensatory mechanism to replace the loss. It must not be thought that normally cerebrospinal fluid is secreted at this rate. Its circulation is under ordinary circumstances quite sluggish. In the occipital region the blood may accumulate in the scalp and form a haematoma there. In fracture of the anterior fossa blood often passes into the orbit. If in great quantity it may produce actual protrusion of the eyeball. Usually it is smaller in quantity and infiltrates the tissues of the orbit from behind, forwards, so that the staining is found in the eyelids and under the conjunctivae. It is characteristic that the bleeding under the conjunctivae proceeds forwards. It may not reach the cornea, but never, however much the patient rolls his eyes to one side, is it possible to see its limits behind. A subconjunctival haemorrhage from a blow on the eye is always greatest at the corneal margin and white sclerotic may be seen behind it. In an ordinary "black eye" the staining is not confined to the eyelids but is, from the first, spread widely over the neighbouring face and forehead. To begin with, the bruising of the eyelids in fracture of the anterior fossa has its boundaries at the orbital margins because of the attachment of the orbito-tarsal fascia. In very bad fractures of the base, brain matter may actually be expressed from the external auditory meatus. There is not normally any displacement of the fractured edges in fractures of the base. A patient can scarcely survive the very severe injury necessary to produce this.

Certain nerves are likely to be injured with fracture of the base: the olfactory and optic in anterior fossa injuries, the facial and auditory

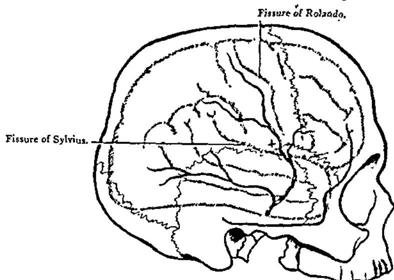
when the petrous bone is injured, and the abducent nerve from its close relation with the posterior clinoid process. The other cranial nerves suffer much less often. More serious than the fracture itself is the accompanying brain injury. This may be compression from haemorrhage, or actual contusion or laceration of the brain tissue. A number of small haemorrhages may be scattered through the brain substance causing little points of softening or sclerosis. Sometimes a large vessel is so injured that some considerable time after the accident it gives way within the softened brain (traumatic apoplexy). Laceration of the brain occurs particularly at the frontal or temporal poles. Then there is the phenomenon of contracoup which must be explained. When a blow falls upon the skull the brain may be damaged at a spot where it is driven against the skull diametrically opposite the site of the blow. This is said to be an injury by contracoup. It is surprisingly unusual for fractures of the base to become septic considering the fact that so many of them are compound. The free and constant escape of cerebrospinal fluid no doubt offers a barrier to the entry of organisms. When infection occurs meningitis is set up and the prognosis becomes extremely bad but not hopeless (page 140).

Intracranial Haemorrhage

Intracranial haemorrhage associated with a head injury may be extradural, intradural or intracerebral.

Haemorrhage from the Middle Meningeal Artery is of particular interest because of the very distinctive signs to which it gives rise and also because of the mechanism by which it is produced. The blood usually comes from the anterior branch or from the accompanying veins. In its elastic recoil to its proper contour the skull, after a momentary traumatic indentation in the temporal region, tears itself away from the flaccid inelastic dura. This separation only lasts for a very short time but is of importance because the vessels adhere to the dura and are thus pulled out of their grooves in the deep surface of the skull. This is not possible at the lower inferior angle of the parietal bone where the groove becomes a canal. It is this fixation which causes the vessel to tear with the outward spring of the skull in its elastic recoil. Owing to the fall of blood-pressure due to the accompanying concussion, no bleeding takes place between the dura and skull at first; they remain in contact. As the concussion passes off the blood-pressure rises sufficiently to overcome the pressure of the brain against the bone and bleeding occurs. It proceeds slowly and progressively because, as the intracranial pressure rises, so does the blood-pressure. The original area of dural separation is much

increased so that the extradural accumulation will extend to the vertex above and the base below. Thus arises the very characteristic syndrome of intracranial haemorrhage. The initial concussion, the period of recovery from the concussed state, if the brain be not damaged, during which time consciousness may return, and the subsequent lapse into compression when the blood-pressure rises enough for bleeding to occur. The lucid interval is usually short but may be some hours or even a day. Added to the symptoms of compression



The middle meningeal artery. A + shows where the anterior branch usually ruptures at the antero-inferior angle of the parietal bone. This point is not far from the centre for the face in the lower part of the Rolandic area.

are localising signs. Because the third nerve is compressed as described on page 121, or thrust against the clivus of the sphenoid bone, *the pupil on the side of injury is first contracted then dilated.* It is irresponsive to light. The same changes, with increasing compression, ultimately take place in the opposite eye. The clot spreading upwards from over the temporal lobe presses first upon the arm and face areas. Hence arise opposite facial weakness and arm signs (twitchings, then paralysis of spastic type with increased tendon reflexes). Later still the paralysis of the same character spreads to the opposite side of the trunk and lower limb. Finally the patient will die from compression (page 122). Sometimes it is the posterior branch of the middle meningeal artery that is torn; sometimes such a haemorrhage is on the opposite side of the skull by contracoup. The skull is very often fissured over the temporal fossa which may be revealed by a haemorrhage into the scalp in this region. The injury is scarcely ever seen in young children but does occur even in babies.

Intradural Haemorrhage.—This is much more common than that

just described. It comes from laceration of the veins running from the brain to the dural sinuses or from superficial cerebral veins when there is laceration, or occasionally from a large artery or venous sinus within the skull, in which case the patient dies rather quickly. The blood is extravasated beneath the arachnoid though sometimes there is a little between this membrane and the dura. It is spread out over a considerable area of the brain as a rule. Just as in middle meningeal haemorrhage, there may be a period of recovery from the concussion before the haemorrhage of reaction occurs. The symptoms are those of compression of the brain with perhaps local phenomena associated with the cerebral hemispheres (page 122).

Intracerebral Haemorrhage.—This is rare. It has been referred to on page 131.

Massive Traumatic Cerebral Oedema.—An injury to the brain tissue is accompanied by oedema in the neighbourhood. This oedema may be so great that it causes a considerable rise of intracranial pressure. Such pressure comes on about 24 hours after the injury so that concussion passes into compression, in which state the patient may be very irritable and violent.

The Treatment of Head Injuries

In itself a fracture of the skull is not serious. The gravity of the accident lies in the accompanying damage to the brain. This may be severe with no injury to the skull, or a skull fracture may be present with neglible brain trauma. Treatment therefore is directed mainly to the intracranial condition.

Concussion.—The patient should be kept lying flat and warm. No stimulants must be given because of the risk of aggravating any bleeding which may be going on in the skull. If the concussion is of short duration no treatment is necessary except rest in bed for at least ten days. Headache may be due to low tension of the cerebrospinal fluid proved by spinal puncture, in which case 30 c.c. of distilled water intravenously will often give relief. He may be very sensitive to light and noises. If so, he must be guarded from loud sounds and the room darkened. The diet should be light. Do not let him see too many visitors, but do not keep them altogether away. He will require rest from work and all worry for at least a month and perhaps longer. The coming on of deep sleep and a slowing of the pulse are the danger signs indicating the onset of compression.

Should the patient be restless from cerebral irritation it may be necessary to give him luminal in 2-grain doses 6-hourly until he becomes quiet.

Compound Fractures of the Vault.—It is necessary to disinfect and shave the parts surrounding the wound and excise its soiled edges. Loose fragments of bone are removed and depressed bone elevated. The dura will usually be intact. The wound is sutured completely. Even in fissured fractures a small trephine opening should be made. This will allow the extravasated extradural blood to be evacuated and provide drainage against infection. If the dura is torn and the brain tissue injured, any vessels found bleeding must be ligated with fine silk or closed with silver clips. Damaged brain is removed by suction. A foreign body within the brain must be extracted with forceps. The track in the brain is explored with a fine catheter attached to a suction apparatus. The laceration in the dura should not be extended.

Closed Fractures of the Vault.—When there are no intracranial complications there is no need to operate upon a fissured fracture, nor upon a pond fracture in a child. In a depressed fracture it is advisable to elevate bone encroaching upon the skull cavity. This is done by making a small trephine opening at the edge of the depressed area through which an elevator is thrust. Do not forget that the inner table may be splintered when the outer is not and that this will only be revealed by an X-ray.

Fractures of the Base of the Skull.—When they are uncomplicated they need no direct treatment. It is particularly unwise to irrigate the nose or external auditory meatus with a view to disinfecting them. These cavities may be freed from blood by careful swabbing with small pledgets of wool and a loose plug may be left in the ear.

In the vast majority of cases, however, there will be signs of intracranial damage. For concussion there is little that can be done except to keep the patient warm and recumbent, perhaps with his feet raised. A careful watch must be kept for the onset of symptoms of compression (page 119) or intracranial haemorrhage (page 131). Whilst the slowing of the pulse and the rising of the blood-pressure have great significance, the most reliable information is obtained by lumbar puncture. In the recumbent position the cerebrospinal pressure is about 8 mm. Hg or 10-11 cm. H_2O. It may well be double this. Lumbar puncture is the most effective way of lowering the intracranial tension, and may be repeated daily or even twice a day for this purpose. The usual practice is to reduce the pressure at each puncture to a point half-way between the pressure registered and the normal cerebrospinal pressure. Lumbar puncture also gives other information. If it is blood-stained it will be known at least that there is some subarachnoid haemorrhage. Another way of lowering intracranial pressure is to inject a hypertonic solution of

glucose (30 c.c. of 50 per cent) intravenously. This raises the osmotic pressure of the blood and causes fluid to be attracted into it from the cavity of the skull. Hypertonic sodium chloride may also be used. It is quicker in action, has less lasting effects, but is very useful when operating upon the brain. Considerable doses of magnesium sulphate (45 c.c. of a saturated solution) by mouth or 6 oz. of 50 per cent solution per rectum also do something to reduce intracranial tension and should be frequently given in the treatments of head injuries. Leriche has described cases of concussion in which there persists intracranial hypotension as shown by lumbar puncture, with small rapid pulse and intractable frontal headache. Great relief in such patients is afforded by the injection of 20 to 30 c.c. of distilled water intravenously.

There are cases in which spinal puncture fails to bring the pressure down, the symptoms of compression persist. Of the very greatest help is the ophthalmoscopic appearance of the fundus oculi, the dilatation of the retinal veins and the blurring of the nasal side of the optic disc. If there are just general signs of compression which do not give way to the above treatment with no localising signs, a decompression should be performed. A large osteoplastic flap is turned down on the right side and the dura opened. There may be nothing further needed, the brain just presenting a waterlogged appearance. The flap is replaced and the wound closed. A considerable bulge occurs, but as the oedema subsides the bone flap sinks back into its normal position. Sometimes the left side may need decompressing as well. The right side is chosen because, on the other side, should the bulging brain press upon the margin of the aperture in the skull, some damage may be done and aphasia result.

When there has been a lucid interval followed by signs of compression, operation is imperative. If the signs point to middle meningeal haemorrhage, open the skull at a point 1½ inches behind the external angular process of the frontal bone and 1½ inches above the zygoma. The clot pushing the dura inwards will immediately be seen. The bleeding point is ligated by under-running the vessel with a fine suture. No more should be done. The results are very satisfactory. If, however, symptoms of compression persist, the wound must be opened again and the dura incised for intradural haemorrhage may be present as well. The dura must always be opened should no extradural haemorrhage be found or if the dura is tense and bulging, and the imprisoned blood allowed to escape. Should a cerebral vessel be actually bleeding it should either be under-run or compressed with a tiny metal clip. Very often, however, the source of the haemorrhage is not discovered.

Operation should not be performed in the later stages of compression with bulbar symptoms (page 122): such patients always die. Compression delayed even for days occurs occasionally from a clot dislodging from a vessel owing to some exertion or from an injured cerebral artery (traumatic apoplexy, page 131). Sometimes such an intracerebral haemorrhage has presented on the surface when the skull has been opened, thus giving relief.

Intracranial Haemorrhage of the New-Born.—During parturition excessive compression of the skull may displace the cranial bones and actually tear one of the veins draining into the superior longitudinal sinus. Blood is extravasated over the surface of the brain, causing convulsions, coma and paralysis. If such unilateral symptoms occur in a baby at birth or a few days after, it is generally held to be wise to open the skull and evacuate the extravasated blood.

The Sequelae of Head Injuries

After all head injuries, even after those in which the intracranial damage appears to be very slight, it is wise to restrict the cerebral activities of the patient for a long time, in order to diminish the likelihood of certain derangements of the higher brain functions coming on. They are particularly loss of memory and an inability to concentrate the attention on anything for very long at a time, so that the patient is quite unable to carry out any work requiring a sustained effort. There may be fine alterations in character so that the patient is irritable and unreasonable, sometimes emotional and sometimes lacking in the inhibitions which make ordinary civilised life tolerable. He no longer respects ordinary social conventions, and is untidy in habits. Headache may be persistent and very intractable. A certain number of cases of insanity are directly due to an injury of the brain. A very serious result is the occurrence of epileptic attacks. These depend upon the irritation of scar tissue after an injury to the brain substance, the presence of meningeal adhesions or an arachnoid cyst the result of haemorrhage. This is true traumatic epilepsy.

When the after-effects of a head injury make their appearance the patient should be kept quietly in bed and freed, as far as possible, from all intellectual activity or excitement. There will nearly always be found increased intracranial tension. Therefore a lumbar puncture should be made to determine this. The headache may be relieved by the sitting position in bed and the administration of 6 oz. of a 50 per cent solution of magnesium sulphate per rectum every day. When

the headache persists in spite of this treatment, the injection of air into the lumbar puncture needle is sometimes effectual. Successive 10 c.c. amounts of cerebrospinal fluid are removed and replaced by 10 c.c. amounts of air until a maximum of 100 c.c. have been injected. The patient must be in a position in which his head is raised above the rest of the spinal canal. It is supposed that the air entering the skull breaks down fine adhesions which have formed between the arachnoid and brain. In exceptional cases a right decompression should be considered. A close observation must be kept for any localising symptoms, for it must not be forgotten that the cause may be a local one such as a chronic subdural haemorrhage (see page 138) or an arachnoid cyst.

The treatment of traumatic epilepsy is not very satisfactory if at operation nothing but adhesions of the arachnoid or a cortical scar is seen. The removal of a scar in the brain is liable to be followed by the production of new glial tissue formation and the separation of arachnoidal adhesions by their re-formation. The epileptiform attacks disappear for a time to return again later. Still it seems, from published experience, worth while excising a scar of the cortex, and it is certainly right to close a gap in the skull by a plastic operation should one be present. Progressive mental deterioration is rare with traumatic epilepsy.

There is no surgical treatment for true traumatic insanity, but always a careful neurological watch should be kept on the patient because an injury sometimes seems to determine the formation of a tumour in the brain.

Some Uncommon Results of Head Injuries

Pneumatocele.—A rare result of fracture of the base of the skull is the entrance of air into the cranial cavity when the frontal sinus or mastoid cells have been opened into. This pneumatocele is seen more often in the frontal region and gives rise to symptoms weeks or months after the accident. They are those of compression (page 119) associated with local frontal or occipital symptoms (page 122). In addition there is rhinorrhoea (escape of cerebrospinal fluid) following sneezing. The X-ray reveals the air bubble, which may be between the brain and skull or actually within the hemisphere.

The best results seem to have been obtained by making an osteoplastic opening in the skull (usually in the frontal region) and suturing the rupture of the dura after lifting up the brain.

Traumatic Cephalhydrocele.—In children a fracture of the vault may allow escape of cerebrospinal fluid into the scalp when it forms a

fluctuating swelling. It is best left alone as the fluid will ultimately be absorbed.

Chronic Subdural Haematoma.—This result of a head injury comes on as a rule a month or two after the accident but its onset may be delayed for several years, or again it may come on in a few hours. No age is immune from it. When established a clot is found between the dura and arachnoid surrounded with a fibrous tissue capsule; in time it becomes a bag of brownish-red fluid. It is very adherent to the dura but only has a slight attachment to the arachnoid. The condition is bilateral in more than one-third of the cases. The onset is insidious and the symptoms at first vague. They never become very distinctive. They are those of general increased tension in the skull together with those due to pressure on the frontal region. There are headache which gradually becomes very severe, drowsiness and slow pulse. Optic neuritis is not so common. There are the alterations of character and the irritability and other phenomena seen in frontal lesions. Perhaps there will be paralyses and convulsions. The symptoms are very variable so that the diagnosis is never much more than a guess.

Such symptoms coming on after a head injury call for operative treatment. A U-shaped flap of scalp is turned down from the side of the skull. A hole is bored over the upper frontal region. If a haematoma is found, another similar hole is made in the upper part of the parietal region over the hinder end of the clot. An irrigation of normal salt solution is now made from one hole to the other. This is found to be sufficient in most cases. Should the containing fibrous capsule be thick or the clot solid, it may be better to make an osteoplastic flap and remove the whole sac. If, as usually happens, the surgeon is content to do no more than irrigate the fluid away, he should always explore the opposite side at the same operation because of the frequency of the bilateral nature of the condition.

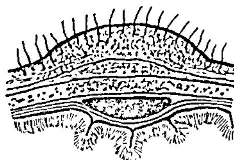
Septic Meningitis, a complication of fracture of the skull, is referred to under meningitis.

Septic Inflammatory Processes within the Skull

Extradural Abscess

This is a collection of pus between the skull and the dura mater. Such abscesses are found in the region of the mastoid antrum, around the lateral sinus, under compound fractures, and deep to infected air sinuses. A cellulitis on the surface of the skull corresponding to the

extradural abscess forms what is called "Pott's puffy tumour". There are, of course, the symptoms of the initial condition. Added to these are fever, headache, local tenderness, and finally signs of intracranial pressure.



Pott's puffy tumour. The scalp and pericranium are swollen and infiltrated over an area of osteomyelitis, with an extradural abscess.

An extradural abscess must be drained. In the case of a compound fracture the bone around the break must be removed over a sufficient area to allow free exit for the pus. Penicillin must be given. The same principles must be put into practice when the abscess is due to infection in the mastoid antrum or an accessory sinus.

Septic Meningitis

In meningitis there are very high fever of the intermittent type, irritability, restlessness, great sensitiveness to all external stimuli, intense headache and rapid pulse. The neck muscles are stiff, the abdomen retracted, the knee-jerks exaggerated, Koenig's sign is positive and there may be convulsions or paralyses of the extremities and perhaps a squint. Koenig's sign is the inability passively to extend the leg on the thigh when the thigh is at right angles to the body.

Septic meningitis can arise in several ways:

(1) By the blood-stream bringing streptococci or pneumococci from some distant place. This can happen in endocarditis or in infections of the lungs, bronchiectasis or abscess. A pneumococcal meningitis can actually happen with pneumonia after an abdominal operation. Lumbar puncture and sulphanilamide may bring about a cure.

(2) By extension from a neighbouring inflammation. Among such causes may be enumerated otitis media, infection of the ethmoidal cells or frontal sinus, compound fracture of the vault, fractures of the base, infections of the scalp, face or neck. The infecting agent is the staphylococcus or the streptococcus.

(3) By way of the nose, the infection being the meningococcus.

In this serious disease there is no time to wait for a test of penicillin sensitivity. Penicillin should be given by lumbar puncture: 20,000 units daily together with 10,000 units intramuscularly every three hours. When the meningococcus is the infecting organism, sulphadiazine should be given as well.

When the infection spreads from the ear or nose it is localised to begin with and prompt drainage may save the patient. A previous mastoid wound should be reopened to drain the dura, or in the case of the frontal sinus the frontal bone should be trephined for the same purpose.

When a fracture of the base of the skull becomes infected the outlook is very grave but not altogether hopeless. A subtemporal opening should be made, the dura opened and a drain of rubber tissue inserted underneath the temporal lobe towards the base of the skull. There has been a certain number of recoveries.

Abscess of the Brain

Abscess of the brain arises most frequently by extension of sepsis in the middle ear. Open fractures of the skull or suppuration in the paranasal sinuses are the next most common causes. Much rarer are

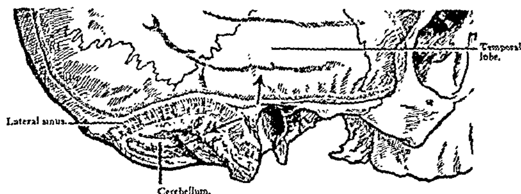


Diagram to show how infection can spread from the mastoid antrum to the cerebrum, lateral sinus, or cerebellum. The white triangle (Macewen's triangle) from which the arrows point marks the position of the antrum.

metastatic abscesses from organisms coming to the brain from infections of the lung, for instance, or by direct extension along the veins in infections of the face. Because mastoiditis is the commonest cause, the site of the abscess is the temporal lobe or the cerebellum. The encephalitis which ultimately breaks down into an abscess may be rapid in its evolution or slow. Hence we find acute and chronic abscesses. In the former, since the infection has often directly spread from the surface, the early symptoms may be those of septic meningitis. After the abscess grows in size the symptoms of cerebral tumour in that particular part of the brain will be added. In the case of a compound fracture of the skull with laceration of the dura and injury to the brain, and in which the wound has been excised and bone removed, the first sign is the protrusion of the brain from the aperture in the skull. Pulsation is either absent or very poor. The actual

abscess cavity may not lie exactly under the skull defect but be excentric to it. Its situation may be discovered by brain puncture but care must be taken not to enter the lateral ventricle. Brain abscesses have little tendency to burst on the surface; spontaneous rupture, if it occurs, takes place into the ventricle with fatal result.

Chronic abscesses appear weeks, months or years after a brain injury, or in the course of a chronic otitis media or nasal sinusitis. They have a dense capsule which the acute abscess lacks and contain thick pus of a greenish colour. These chronic encapsulated abscesses are not very tightly bound to the surrounding brain tissue from which they can be actually shelled out entire.

The illness often begins acutely with a rigor, rise of temperature and severe headache. After a few days these acute symptoms subside almost entirely and there follows a long period during which, with gradually and increasing intensity, appear the symptoms of cerebral compression (see page 119) with localising symptoms, according to the situation of the tumour in the temporal lobe, cerebellum or frontal region (see page 122). The pulse is particularly slow and the temperature often subnormal. There is either no leucocytosis or the white cell count is not above ten or fifteen thousand. The patient becomes very thin and has a sallow appearance. The illness ends with the pus leaking on to the surface of the brain when the symptoms of acute meningitis arise, or more commonly by rupture into the lateral ventricle, when the patient goes into coma with high temperature and rapid pulse. In either event the patient soon dies, so that it is necessary to make the diagnosis during the long period of gradual evolution.

Treatment.—It has been found that the prognosis is very much better in chronic than in acute abscess, so there is something to be said for a policy of waiting, if the signs of cerebral compression are not rapidly progressive, in the hope that the abscess will encapsulate. When, in middle ear disease, an abscess of the brain is suspected, the mastoid operation is first performed and then the dura exposed in front of and behind the sigmoid sinus. If an extradural collection of pus is found here, this is drained and nothing further is done, unless the symptoms fail to clear up. But if no extradural abscess is found and the lateral sinus is not thrombosed, the temporal lobe, and if necessary the cerebellum, must be explored with a blunt needle, for which purpose a small nick is made in the dura for its passage. If the abscess is acute, aspiration without drainage should be done. In chronic abscesses aspiration, which may have to be repeated, is also advocated.

An alternative is to enlarge the dural opening sufficiently to allow of the insertion of the blunt end of a rubber catheter, which should

be left in until all discharge ceases. When a chronic abscess resembles in its clinical behaviour a brain tumour, the part of the brain in which it seems to lie may be exposed by an osteoplastic flap and the necessary evacuation carried out. This is a serious operation in a weakened patient, and drainage through a bone defect of any size is liable to be followed by troublesome protrusion of inflamed brain tissue. Another and perhaps better plan is to make one or more small trephine openings and to explore for the abscess through these. When found, the abscess is treated either by aspiration or drainage as above. In a few cases small abscesses with very thick walls have been excised with successful result.

Fungus Cerebri

This is the name given to a granulomatous formation which occurs when, with an opening in the skull, there is encephalitis of the underlying brain tissue. Such protrusions of brain substance usually reach quite large proportions. They are seen after operations for abscess of the brain and with compound fractures of the skull associated with brain damage. The protrusion is apparently due to the damaged brain, in the absence of the support of the dura, being unable to oppose the normal pressure of secretion of fluid into the lateral ventricle. The ventricle distends and herniates through the opening in the skull.

When the infection subsides and the oedema disappears the whole mass shrinks and recedes into the skull so that in the end there is a depression in place of swelling. The treatment is lumbar puncture, daily if necessary, a covering of rubber tissue over the fungus and protection from pressure by a thick surrounding ring of rolled-up gauze.

Infective Sinus Thrombosis

The sinuses of the skull may become thrombosed as the result of extension of infective processes in their area of drainage, the lateral sinus in otitis media, the cavernous sinus in carbuncles of the face or suppuration in the orbit, the longitudinal sinus in subaponeurotic abscess of the scalp.

Lateral Sinus Thromboses.—This is the most common and is seen as a complication of acute otitis media, especially after a mastoid operation has been done. The symptoms are a combination of those of pyaemia with those of meningitis. There are repeated rigors with a high and widely fluctuating temperature, sweating, severe headache, irritability, mental dulness or stupor, and delirium. Stiff-

ness of the neck muscles may be present. If the clot in the vein extends down the jugular there will be tenderness in the neck. Sometimes the cervical glands are enlarged. Spread may actually take place along the petrosal sinus and reach the cavernous sinus, when signs of this being affected will be added. As in other forms of pyaemia, septic emboli reach the lungs; the pulmonary symptoms thus produced may be so intense as to overshadow completely the other clinical signs *so that the actual source of the pyaemia may remain unsuspected.*

When the diagnosis of lateral sinus thrombosis has been made, the mastoid antrum should be opened and the bone behind it nibbled away so as to expose the sinus. Pus will be found surrounding it, and as a rule its walls will be covered with granulations.

It having been determined that the sinus is clotted by its appearance, by puncture or by incision, this wound should be left and, with a clean set of instruments, the jugular vein should be exposed in the neck. Here it should be ligated below any clot which may have formed in it and divided above the ligature. Returning to the mastoid wound, the surgeon freely exposes the lateral sinus and cuts away its wall to provide good drainage. It is not necessary to curette away the clot until blood flows. The lower part of the vein may be cleared by irrigating with saline solution through the upper divided end of the jugular vein in the neck. The wound is left freely open. Penicillin should be given as for septic meningitis (page 139). The prognosis is grave, particularly so when pulmonary symptoms are prominent.

Sometimes a thrombo-phlebitis of a much milder character occurs which subsides without suppuration occurring within the sinus, or the vein becoming completely obstructed. In these cases the symptoms abate but are followed by those of raised intracranial pressure. This is because inflammation round the sinus causes fibrosis of the invaginating arachnoid villi; the drainage of cerebrospinal fluid into the sinus is hindered; and an external hydrocephalus results. Repeated lumbar puncture in the early stages may cure the patient. In persistent cases a suboccipital decompression is necessary. The bone over the corresponding occipital fossa is removed. This alone may allow of sufficient expansion of the brain. If it proves to be inadequate the dura must be opened.

Cavernous Sinus Thrombosis.—Infective cavernous sinus thrombosis was invariably fatal until the advent of penicillin. Now some cures have been reported. When it comes on as a complication of a carbuncle of the face, the thrombosis has spread by way of the facial angular and ophthalmic veins. There are great oedema of the eyelids, chemosis of the conjunctiva and protrusion of the eyeball.

There is retinal haemorrhage and the sight goes. There are severe headache and the signs of pyaemia. Untreated the patient dies in a few days but he may live long enough for the same changes to appear on the other side, for the clot is very apt to spread in front of the pituitary fossa to the sinus of the opposite side. Penicillin treatment must be vigorously pursued.

Intracranial New Formations

Under this heading, because the clinical features are so similar, are included true *tumours, gummata, tuberculomata* and *parasitic cysts*.

They may be classified as follows:

1. Tumours of the Meninges.
   - (a) Meningioma.
   - (b) Sarcoma of the Dura.
2. Gliomata.
3. Perineural Fibroblastoma of the Auditory Nerve.
4. Hypophyseal Adenomata.
5. Craniopharyngioma.
6. Granulomata.
7. Secondary Metastatic Tumours.
8. Hydatid Cysts.

Intracranial tumours reveal their presence by evidence of gradually increasing general pressure within the skull and the signs of local pressure. For an account of these symptoms the reader is referred to pages 119-126. Here the differing characters of the several growths will be considered briefly.

Meningiomata are really a sort of over-developed Pacchionian bodies and so occur in the neighbourhood of the venous sinuses: near the superior longitudinal sinus, the posterior margin of the small wing of the sphenoid, the cribriform plate, the transverse sinus. They do not occur below the tentorium. They have other names: *dural endothelioma, psammoma, fibroblastoma of the arachnoid*. They occur in middle life. Although they are really growths of the arachnoid, they easily separate from this membrane but are adherent to the dura. They are encapsulated tumours but grow right through the skull, even invading the scalp. A reaction is caused in the bone which is shown in the X-ray photograph by an increase in area and an irregularity in the shadow. The parasagittal tumours give rise to frontal lobe symptoms. When arising from the tuberculum sellae there is bitemporal hemianopia with normal sella in the X-ray and with no

signs of involvement of the pituitary or hypothalamus. Also the patient is middle-aged. Growing from the sphenoid there is often unilateral exophthalmos, homonymous hemianopia or uncinate seizures. In the olfactory groove they cause ipsilateral anosmia and pressure optic atrophy, whilst later they will show signs of pressure on the frontal lobe.

Meningiomata cause all their symptoms by displacing the brain tissue; they do not destroy it. From this point of view, therefore, they are suitable for operative treatment. On the other hand the technical difficulties are very great because of their extreme vascularity and that of surrounding parts. Osteoplastic flaps are turned down in the region of the tumour. Local anaesthesia is advisable because the adrenalin diminishes haemorrhage. At this stage bleeding from the bone or from veins on the dura may necessitate the abandoning of the operation. Hot saline packs, the coagulating diathermy current and pieces of muscle may all be requisitioned for purposes of haemostasis. A blood transfusion may be required. The dura is cut all round the margin of the tumour, which is gradually raised up from the surface of the pia-arachnoid towards the sinus from which it has arisen. It is cut off the sinus, which is closed with clips or sutures. Sometimes a portion of the sinus must be resected. This is a very serious step in the case of the superior longitudinal sinus. Meningiomas at the base of the skull cannot be enucleated in this way. They are scooped away piecemeal with the diathermy loop.

Sarcoma of the dura occurs as a tumour invading the bone of the skull, eating it away without producing the increased bone formation seen in arachnoid fibroblastoma. Like the latter, however, they do not invade the arachnoid. Also they have a very slight tendency to form metastases.

The *Gliomata* include all tumours growing from the cells lining the primitive groove. These cells give rise to the nerve cells of the brain and to the neuroglia. By special methods of staining, gliomata have been divided into a number of groups according to the characters of the cells of which they are composed. Some of the cells resemble mature cells, others have reverted to an embryonic stage of their existence. The classification of the gliomata has become very complicated but is justified by the differing clinical course of the several varieties, so that if the histological nature of a glioma be known some idea of the future of the patient can be conjectured. There are only three common forms. They are the glioblastoma multiforme, the astrocytoma and the medulloblastoma.

The *Glioblastoma Multiforme* is made up of bipolar fusiform cells so that it used to be called a spindle-celled sarcoma. It is a soft tumour

which does not possess a capsule. It is designated *multiforme* because there is a number of other varieties of neuroglial cell contained in it. It is found almost exclusively in the cerebral hemispheres of adults. It grows rapidly and is prone to haemorrhages and degenerations.

The treatment of this tumour is very unsatisfactory and disappointing. Very few of them are removable and radiation treatment appears to be of very little use.

The *Astrocytoma*, on the contrary, is of slow growth. It may occur anywhere in the brain. It constitutes 50 per cent of cerebellar tumours in children (the other 50 per cent being medulloblastomata). It commonly degenerates into a cyst leaving one actively-growing mural nodule. Such cysts may be exposed by incision of the brain tissue, opened, evacuated of their contained fluid, and the mural nodule removed by the diathermy knife. After this removal the patient may be free from symptoms for years.

The *Medulloblastoma* occurs chiefly in the cerebellum of children. This tumour is composed of a very embryonic type of cell of the neural groove. It is a soft reddish-grey solid tumour without a tendency to cyst formation.

Here again treatment is unsatisfactory. If these growths are removed they quickly return, so that they are scarcely worth excising, especially as radiation is very effective temporarily.

There are several other forms of gliomata met with, but they are rare and cannot be considered in detail here.

For the symptoms of all these tumours, the reader should refer to pages 119-126.

It must not be thought that only cystic gliomata can be treated by surgery. It is often worth while operating upon slow-growing solid diffuse gliomata, for they may be partially removed with the diathermy knife loop and the patient get much relief. If the tumour be situated in a silent area such as the temporal or right frontal lobe, a large portion of the brain may be removed. Statements to the contrary notwithstanding, removal of a part of the frontal lobe is always followed by impairment of the intellectual functions and some deterioration of character and alteration of personality.

Gliomata situated towards the base of the brain are not removable. When, at an operation, they have been proved to be inaccessible, the dura should be left open and a large part of the bony flap be removed before sewing up the scalp so that the brain shall be decompressed. When a cerebral tumour is known to be present but it is not possible to localise it, a deliberate decompression operation should be performed to relieve the headache and perhaps to restore, or at least preserve, the sight. This consists in the making of a large osteoplastic

flap, opening widely the dura, replacing the bone loosely and suturing the scalp. The operation should only exceptionally be done on the left side because of the danger of aphasia being caused by pressure of the brain on the margin of the aperture in the skull as it is thrust out beneath the scalp. This in general is too great a price to pay for the relief afforded.

Perineural Fibroblastoma of the Auditory Nerve.—This interesting tumour arises from the vestibular division of the auditory nerve in the internal auditory meatus. Out of this it grows, pressing upon the neighbouring parts of the brain. It has a sort of capsule formed of the arachnoid. Of surgical importance is the fact that over the surface run numerous branches of the basilar artery; there is a number of veins also. The tumour is often cystic and sometimes concealed from behind by an arachnoid cyst.

The first symptoms are usually tinnitus or deafness, which may last for a very long time. Then comes on vertigo. Irritation of the seventh nerve causes facial spasms or weakness, though this is rare. Pressure on the fifth nerve causes tingling or burning in the face and mucous membrane of the mouth and disturbance of taste with hypo-aesthesia of the cornea. Actual neuralgia is unusual. The ninth, tenth and eleventh nerves may later be pressed upon, giving rise to difficulty in swallowing and articulation. Or the cerebellum may be affected so that the patient drops things with one hand, and his gait is unsteady and the muscles of the neck stiff. When the tumour is large of course there are the signs of intracranial tension, headache, vomiting and optic neuritis.

Rarely the tumour is a part of generalised von Recklinghausen's disease.

These tumours may be operated upon and very great relief accrue, but the operation is associated with some danger. The dangers arise from haemorrhage and from the oedema which may follow the operation and force the medulla oblongata down on to the margin of the foramen magnum, causing death. The bone is removed from over both cerebellar hemispheres and the dura opened. The lateral lobe of the cerebellum is raised to expose the tumour. Some surgeons actually remove some of the lobe to facilitate access. The capsule of the tumour is incised and the tumour removed piecemeal. A good deal of blood may be lost. It is not usually wise to attempt to remove the capsule because of the haemorrhage that is likely to be met with, and because it is not possible to peel the membrane off the facial nerve without damaging this structure. Relief may be given to the patient for years.

Hypophyseal Adenomata.—In the anterior lobe of the pituitary gland

reside three kinds of cells: some which have no affinity for stains, some which have granules staining with acid dyes, and some whose granules stain with basic dyes. Adenomata may arise from any of these elements: those from the chromophobe cells are the commonest; the acidophilic adenomata come next in frequency; whilst the basophilic adenomata are rare, never grow to any size and are of little surgical importance. As the adenoma grows the hypophysis itself is compressed almost to nothing, the sella turcica is expanded, the optic chiasma is pressed upon in front as the tumour grows upwards, whilst the growth may actually extend downwards into the sphenoidal sinus, and indeed into the pharynx. Patients with chromophobe adenomas exhibit signs of hypopituitarism: a dry smooth pale skin, scanty body hair with feminine distribution in males, fine silky scalp hair and a rather characteristic finely wrinkled forehead. Drowsiness, lassitude, polyuria, polydipsia and adiposity from pressure upon the hypothalamic region, also occur. There is depression of the sexual function.

Acidophilic tumours when they grow before the epiphyses have united cause gigantism; when they appear in adult life they give rise

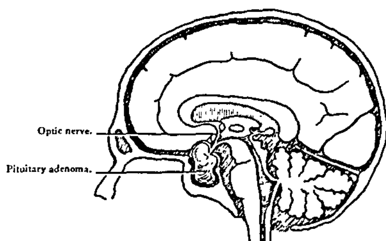


Diagram to show how an adenoma of the pituitary enlarges upwards into the skull and presses upon the optic chiasma. The pituitary fossa is very much distended.

to the symptoms of acromegaly. In this there are thick coarse skin, hypertrichosis and excessive sweating. The lower jaw becomes greatly hypertrophied and projects so that the teeth do not approximate properly. The thick protruding lower lip is very ugly. The hands and feet are enormously enlarged, all the tissues composing them being affected. There is often a stoop. The basal metabolic rate is increased in this disease, whilst in chromophobe tumours it is diminished.

In both kinds of tumours headache and visual defects arise. As the tumour rises in front of the chiasma it presses upon the nasal

aspects of the two optic nerves so that loss of vision in each temporal field results. Since the pressure comes from below, the defect begins in the upper quadrant first. Should the tumour grow asymmetrically, as sometimes happens, this characteristic alteration of vision may be replaced by a complete loss of sight in one eye. In many acromegalics the tumour never gets large enough to produce eye symptoms.

Operation should be performed for the relief of visual symptoms and for the headache. An osteoplastic flap is turned down in the frontal region. The dura is incised and the frontal lobe raised, thus revealing the tumour projecting up between the optic nerves. It may be cystic. The roof of the sella is opened and the tumour removed by suction or gentle curetting. Bleeding must be stopped by diathermy, hot saline solution or by pieces of muscle. The results of such operations are good; visual improvement may be expected and the result may be permanent.

The rare basophilic adenomata do not grow large enough to cause local pressure symptoms. They produce a syndrome first described by Cushing. There are obesity of the trunk with striae in the skin of the abdomen and growth of hair on the body and face. Females suffer from amenorrhoea, while males are impotent. There are a high blood-pressure and an increase of the red corpuscles in the blood so that the patient has a bloated appearance. Glycosuria and headache are also present. Similar symptoms are found in some cases of hypertrophy of the suprarenal glands, in carcinoma of the thymus and in rare tumours of the ovary. When symptoms are due to the pituitary gland X-radiation is very effective. When they are due to overactivity of the suprarenal glands excessive excretion of androgens in the urine occurs (100 mg. sterone compared with the normal 5 to 15 mg.). In Cushing's tumours the androgen secretion is either normal or slightly lower than normal.

Craniopharyngioma.—These tumours are epitheliomas arising from rests of the craniopharyngeal duct. They are nearly always cystic, hence the name suprasellar cysts. They lie above the sella turcica and project downwards into the sella, compressing the hypophysis, and upwards into the third ventricle. The sella is not expanded as with a pituitary adenoma. The fluid in the cyst contains cholesterin crystals, is viscid and yellowish green in colour.

Symptoms usually appear before 15 years. They are those of hypophyseal deficiency and those of pressure upon the hypothalamus (see page 126). There is frequently in addition an external rectus paralysis. Examination by X-rays is often helpful, for the cranial bones become separated in children and there is calcification of the cyst.

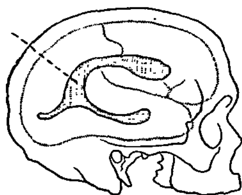
Treatment is not very satisfactory. The cyst is exposed and evacuated. The cyst wall is removed if possible, but this is a difficult technical procedure. The pituitary deficiency cannot be relieved. The mortality is high.

Granulomata.—Granulomata of the brain include gummata and tuberculomata. That gummata may grow in the brain must never be forgotten when a tumour of the brain is suspected in a syphilitic subject. It is, under such circumstances, always worth while to give antisyphilitic treatment and to watch for improvement. Gummata resistant to medication may sometimes be shelled out.

Tuberculomata occur in the brain as circumscribed tumours. It is possible to enucleate them but the prognosis is not good. For one thing, the tumour may not be a single one, so that another tumour is left behind which subsequently gives rise to trouble, whilst it is usually held that operation leads subsequently either to tuberculous meningitis or to generalised tuberculosis.

Ventriculography

This is the filling of the ventricles of the brain with air so that they become visible in an X-ray photograph of the skull. Such a procedure will reveal dilatation of the ventricles or show if they are displaced to one side or collapsed by a tumour. Two small openings in the skull, one on each side, are made, either 2 cm. from the middle line and 7 cm. above the external occipital protuberance or 6 cm. above the external auditory meatus and 3 cm. behind it. From either place it is possible to tap the widest part of the lateral ventricle where the temporal and occipital horns diverge. Some difficulty, however, may be experienced in finding the ventricle if it is much displaced, and particularly if it is collapsed by a tumour. As the cerebrospinal fluid is withdrawn it is replaced by successive quantities of air, but not by quite as much, from fear that the injected air will expand when it reaches the temperature of the body and raise the intracranial pressure still further. The volume injected falls short of the volume of fluid extracted by about 5 c.c. This procedure is extremely useful in the localisation of some cerebral tumours, and indeed may be the only method by which they can


Diagram to show path followed in tapping the lateral ventricle.

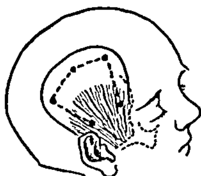
be diagnosed, but some neurological surgeons think that it should only be done when other methods of diagnosis have failed, because sometimes after it has been performed a sudden rise of intracranial pressure comes on which demands an immediate operation. Ventriculography is a minor operation in itself. It is always carried out under local anaesthesia.

Encephalography

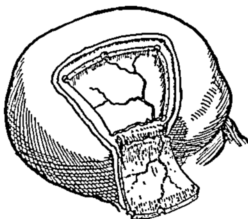
In this procedure air is injected into the subarachnoid space through a lumbar spinal puncture after the withdrawal of cerebrospinal fluid. The air will pass upwards to enter the fourth ventricle through the foramina of Magendie and Luschka if they are open and thence to the lateral ventricles if the iter be patent.

Operations upon the Brain

It has already been pointed out how important it is to have an exact localisation of a brain lesion in order to plan a convenient path



Osteoplastic resection of skull. Incision in scalp in continuous line: bone cut in dotted line. The hinge below is made by the temporal muscle.



Osteoplastic flap turned down exposing dura and middle meningeal artery. It is hinged on the temporal muscle.

of approach (page 117). A fairly large area of the brain can be uncovered by the method of osteoplastic resection of the skull, in which a piece of the skull is turned down like the lid of a box. The hinge is always made in the temporal region, where it is formed by the temporal muscle and its fascia, through which the detached piece of bone obtains its blood-supply. The annexed figures illustrate the usual flaps that are made. The incision in the scalp corresponds roughly to the outline of the bone cut except in the case of the frontal flap, when the scalp is turned down over the eyes by an incision which extends from in front of one ear across the vertex to in front of the other. This is done to avoid a visible scar on the forehead. Four or

more holes are bored in the skull along the line of the proposed incision and connected by cutting between them from within outwards, with a wire Gigli saw, except along the hinge line, where the thin bone in this region is broken so as to preserve its blood-supply through the overlying muscle. The dura is opened by an incision parallel to the opening in the bone, thus exposing the brain. At the end of the operation the bone is replaced and the scalp sutured. If it has been found impossible to remove the tumour it may be necessary to remove a part or the whole of the reflected bone in order to allow the brain to protrude from the skull for the relief of pressure symptoms.

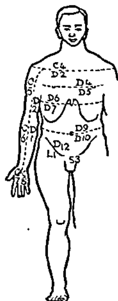
One of the great difficulties in operating upon the brain is the control of haemorrhage. The scalp itself is very vascular and rendered more congested by the increased intracranial tension. If the line of incision be infiltrated with novocain and adrenalin the vascularity is diminished. It is further controlled by clipping a number of Spencer-Wells forceps on the cut edge of the galea aponeurotica and throwing them over on the surface of the scalp, where, by their weight, they cause sufficient pressure to stop the blood from escaping from the vessels of the scalp. Bleeding from the bone itself may be stopped by forcing Horsley's wax (beeswax and carbolic) into the raw cut surface. Vessels of the dura may sometimes be under-run or they may be closed by the diathermy coagulating current, or, when more intractable, by the application of small pieces of muscle which have been taken from the exposed temporalis. Such living muscle is rich in thrombokinase. The pieces very soon adhere to the site of the haemorrhage, where they may be left. This is a very valuable method of haemostasis which may also be used on the brain itself. When small vessels of the cortex or elsewhere cannot be ligatured they may be closed by the small metal clips devised by Cushing. A very useful piece of apparatus is the mechanical sucker which is used for the removal of blood and cerebrospinal fluid which may be obscuring the operative field. Most brain operations are best performed in the head raised position; in some clinics they are done wherever possible with the patient in a sitting posture. The extreme tension of the brain, when the compression is great, is sometimes a serious embarrassment to the surgeon. In such circumstances the brain may be made to shrink by the intravenous injection of hypertonic salt solution or by puncture of the lateral ventricle. After any intracranial procedure the skull should not be closed until the haemostasis is absolute. If the dura will not come together it is not of great account, because a new dura forms very quickly over the exposed brain tissue. The scalp is sutured in layers, and this suturing obviates the necessity for any ligatures upon its blood-vessels.

CHAPTER XV

DISEASES OF THE SPINE AND SPINAL CORD

General Considerations

Like the brain the spinal cord is invested with pia-arachnoid and dura. The arachnoid is not so closely applied to the pia as in the skull, so that it is very easy to enter the subarachnoid space by inserting a needle between two laminae. The ligamentum denticulatum, a process of the pia, is useful surgically because it affords a means of fixing or moving the cord without actually handling this delicate structure. The dural sac ends at the level of the third piece of the sacrum, and the spinal cord at the lower border of the body of the first lumbar vertebra. Hence the segments of the cord do not correspond with the same named vertebrae; the eight cervical segments are opposite the upper six cervical vertebrae; the upper six dorsal segments opposite the upper five thoracic vertebrae; the lower dorsal segments opposite the sixth to the tenth thoracic vertebrae; the lumbar and sacral segments opposite the eleventh and twelfth thoracic and the first lumbar vertebrae. The segmental distribution of the spinal nerves is of great importance in the localisation of a spinal lesion. The neighbouring figure shows the distribution of the sensory roots. It is easy to remember. The line of division between the fourth cervical segment and the second dorsal runs through the manubrio-gladiolar junction, the intervening segments being drawn out into the upper limbs. The line of separation between the fourth and fifth dorsal segments runs through the nipples. The line between the sixth and seventh dorsal segments is at the level of the lower end of the gladiolus, whilst that between the ninth and tenth segments runs through the umbilicus. The division



Segmental distribution of the spinal nerves. There is considerable overlapping.

more holes are bored in the skull along the line of the proposed incision and connected by cutting between them from within outwards, with a wire Gigli saw, except along the hinge line, where the thin bone in this region is broken so as to preserve its blood-supply through the overlying muscle. The dura is opened by an incision parallel to the opening in the bone, thus exposing the brain. At the end of the operation the bone is replaced and the scalp sutured. If it has been found impossible to remove the tumour it may be necessary to remove a part or the whole of the reflected bone in order to allow the brain to protrude from the skull for the relief of pressure symptoms.

One of the great difficulties in operating upon the brain is the control of haemorrhage. The scalp itself is very vascular and rendered more congested by the increased intracranial tension. If the line of incision be infiltrated with novocain and adrenalin the vascularity is diminished. It is further controlled by clipping a number of Spencer-Wells forceps on the cut edge of the galea aponeurotica and throwing them over on the surface of the scalp, where, by their weight, they cause sufficient pressure to stop the blood from escaping from the vessels of the scalp. Bleeding from the bone itself may be stopped by forcing Horsley's wax (beeswax and carbolic) into the raw cut surface. Vessels of the dura may sometimes be under-run or they may be closed by the diathermy coagulating current, or, when more intractable, by the application of small pieces of muscle which have been taken from the exposed temporalis. Such living muscle is rich in thrombokinase. The pieces very soon adhere to the site of the haemorrhage, where they may be left. This is a very valuable method of haemostasis which may also be used on the brain itself. When small vessels of the cortex or elsewhere cannot be ligatured they may be closed by the small metal clips devised by Cushing. A very useful piece of apparatus is the mechanical sucker which is used for the removal of blood and cerebrospinal fluid which may be obscuring the operative field. Most brain operations are best performed in the head raised position; in some clinics they are done wherever possible with the patient in a sitting posture. The extreme tension of the brain, when the compression is great, is sometimes a serious embarrassment to the surgeon. In such circumstances the brain may be made to shrink by the intravenous injection of hypertonic salt solution or by puncture of the lateral ventricle. After any intracranial procedure the skull should not be closed until the haemostasis is absolute. If the dura will not come together it is not of great account, because a new dura forms very quickly over the exposed brain tissue. The scalp is sutured in layers, and this suturing obviates the necessity for any ligatures upon its blood-vessels.

pression fracture. The patient always has pain in the back, with tenderness and bruising, but he may not have cord symptoms. When such a fracture is suspected antero-posterior and lateral X-rays should always be taken. Sometimes the line of fracture is very difficult to see or actually indiscernible. If in the mistaken belief that there is no fracture the patient is allowed to be about and is treated as a contusion, a condition described by a man named Kummell comes on. The patient begins to suffer from severe and increasing pain in the area of distribution of the nerves corresponding to the broken vertebra, that is, pain in the abdomen, because compression fractures are usually found in a lower dorsal or upper lumbar vertebra. With this there is a gradual bending of the back, due to collapse of the affected bone. After a fracture of a vertebral body, perhaps after a contusion without fracture, there occurs an absorption of lime salts as part of the accompanying traumatic osteitis. The weight of the body is then easily able to cause the collapse seen in the X-ray. The pain is due to pressure upon the intervertebral nerves.

Dislocations.—Simple dislocations of the vertebrae occur almost exclusively in the cervical region. In such an injury one vertebra passes forwards upon the vertebra below so that the articular process





Unilateral dislocation of the cervical spine. The one-sided nature is clearly seen in the posterior view.





Bilateral dislocation of the cervical spine.

of the upper bone jumps that of the bone below. By reference to the bones it will be seen that the slope of the articular facets is only really favourable for this movement in the cervical region. In the thoracic and lumbar regions the articular processes must break before one bone can move forward on the other. This is what really happens in the other regions of the spine; there occurs a fracture-dislocation. In the cervical region only one interarticular joint may be dislocated and then there is a rotatory displacement of the upper vertebra. Or both joints may be torn apart. These injuries occur from serious accidents such as diving into shallow water, but on the other hand they may result from quite trivial injuries, actually for instance by a voluntary movement in a child running in play. Also, because the spinal canal

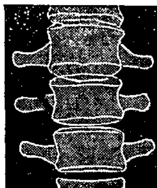
between the thoracic and lumbar segments corresponds with Poupart's ligament. As below this level the spinal segments are crowded together in a narrow area, they do not usually get injured separately, so that it is not so important to remember the distribution of these lower segments. These zones are not innervated solely by one nerve but usually by two or perhaps three, so that a lesion of the cord is situated two or three segments higher than the level of anaesthesia. The muscles also have a segmental innervation, but the important segments liable to injury will be referred to in the accounts of the different injuries and diseases.

Injuries to the Spine

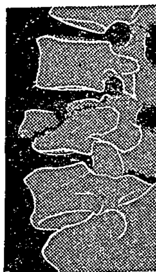
Injuries to the spinal column are classified as:

1. Fractures.
2. Dislocations.
3. Fracture-dislocations.

Fractures.—Isolated fractures of the laminae or spines occur rather infrequently and are due to direct violence; fractures of the transverse processes in the lumbar region are much more common. In the case of the first two a bony fragment may be driven on to the spinal cord;



Skiagram of fracture of a transverse process.



Skiagram of compression fracture of spine.

the last injury is often thought to be nothing more than a contusion of the back.

An isolated fracture of the body of a vertebra is the result of falls on the feet or buttocks or head, or of a heavy weight falling upon the shoulders in the stooping position. The fracture is a horizontal one through the middle of the body. It is also called a crush or com-

broken lamina encroaching on the canal. Long after the accident, signs of pressure may be due to the formation of callus or of an arachnoid cyst. The fact that the sensory and motor fibres in the cord are collected into definite tracts according to function is important to remember. The posterior columns carry the impulses connected with the muscles and joints which give the sense of position and muscular effort, and also a few tactile impulses. They do not decussate until they reach the bulb. Other tactile impulses and those of pain and temperature pass into the cord by the posterior roots and almost immediately cross over to the opposite side to pass upwards in the spino-thalamic tract. So that if one-half of the cord is severed there will be loss of the muscular sense and the sense of position on the same side with loss of pain and temperature sense on the opposite side (Brown-Sequard phenomenon). This, however, is very rare in fractures of the spine. It is more common to get retention of the pain and temperature sense with loss of touch when the peripheral part only of the cord has been crushed.

After an injury to the cord a condition of spinal shock comes on. In this there is complete loss of muscular power and sensation in the body below the lesion; there are loss of control of the bladder and rectum and disappearance of all the reflexes. The exception is that sometimes a purely spinal reflex flexion of the great toe may occur on stimulation of the sole of the foot. Spinal shock may last for a week or two before it passes off, leaving a residual loss of function due to actual mechanical injury of the nerve tissue. During this period it is absolutely impossible to tell what this actual spontaneously irrecoverable loss of function is, an important point to bear in mind when deciding on the desirability of operative treatment. When the spinal shock passes away the flaccid muscles become spastic and the tendon reflexes return and become exaggerated, whilst there is an extensor plantar response in the great toe. The retention of urine which at first was absolute gives way to the extent that the bladder spontaneously empties itself when the tension within it rises to a certain level. Even when there is a complete transverse lesion the flaccidity of the muscles gives way to spasticity with exaggerated knee-jerks, and mass reflexes in the lower limbs appear: that is, a slight stimulus will make the whole limb draw itself up.

With a complete transverse lesion of the cord at the level of the fifth cervical segment all four limbs of the patient are paralysed and the intercostal muscles as well. He breathes by his diaphragm alone. He does not usually live long. When the lesion is at the level of the sixth cervical segment the patient lies in a characteristic attitude with his arms abducted from the sides, the elbows flexed and the

is so large in the cervical region, even a bilateral dislocation is not necessarily followed by any cord injury. In the unilateral injury there is a twisted position of the neck resembling a little the attitude of torticollis. There is absolute rigidity in the abnormal position, and there is tenderness over the displaced articular processes. There may also be severe pain in the distribution of the nerve corresponding to the lower vertebra. A unilateral or bilateral dislocation of the atlas on the axis is sometimes seen and it may be associated with a fracture of the odontoid process. There are rigidity of the head which is thrust forward and local tenderness. In spite of the displacement sudden death does not necessarily follow, though the patient must be considered to be in a precarious condition; indeed there may be no evidence of any pressure upon the cord or the bulb at all. Here also must be mentioned spontaneous dislocation of the atlas. This occurs as a rule in children associated with some infection of the pharynx, perhaps that which sometimes follows tonsillectomy. Apparently the inflammatory process spreads to the neighbouring parts affecting the capsular ligaments of the atlanto-axial joints and the transverse ligament, softening them and allowing the dislocation to take place.

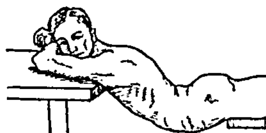
Fracture-Dislocations.—In this condition there are fractures of the body of a vertebra and the articular processes, and the upper part of the spine is displaced forwards. The injury is met with in any part of the spine but is seen more often in the dorsal region. It is accompanied by serious damage to the spinal cord, for, as the upper part of the column moves forward, the cord is crushed between the body of the broken vertebra and the neural arch of the vertebra above. The patient is quite helpless. He can neither sit nor stand. There are bruising of the back and a projection of the spine of the broken vertebra. In compression fractures, the projecting spine is that of the vertebra above the crushed one.


Fracture-dislocation of dorsal spine.

Associated Injury to the Spinal Cord.—In all fractures of the spine damage to the spinal cord is the most serious consideration. A careful neurological examination will reveal the exact level at which the damage has occurred. In actual fact the cord may be crushed completely across, or it may be only crushed on the anterior and posterior aspects, or laterally; the damage may be due to a haemorrhage in the cord or, if it be not immediate, it may be due to an oedema which comes on as the result of a contusion. Rarely it is caused by the pressure of a

there is sometimes difficulty in breathing. This must be provided for by props under the shoulders.

Treatment.—The treatment of injuries of the spine when there is cord damage is not agreed upon by all surgeons, but when the cord is not involved it consists in placing the spine in hyperextension and maintaining this position until the repair has taken place. In compression fractures of the body of a vertebra or fracture-dislocations in the dorsal or lumbar region reduction is performed as follows. No anaesthetic is given beyond ¼ grain of morphine. The patient is then placed face downwards on a table and brought over the edge as far as his groins. His arms and shoulders are supported by another table at a slightly higher level. In this position, as the trunk sags,



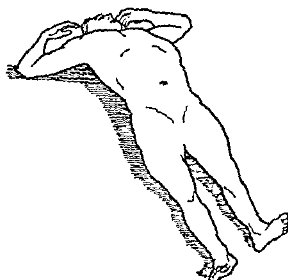
Fractured spine. Position of patient for application of plaster. The jacket must reach from the symphysis pubis to the top of the manubrium in front: up to the angles of the scapulae behind.



Plaster jacket for fractured spine: it extends up to the clavicles in front and down to the symphysis pubis.

the deformity corrects itself. A plaster jacket is put on from the level of the groins to the shoulders. It is cut away over the abdomen. A pressure sore is likely to occur over the dorsilumbar spines, so a piece of felt is placed in this region before the plaster is applied and the casing is cut away here afterwards. As soon as the plaster is hard the patient may sit up, and in a week he may walk. If the spine is sufficiently hyperextended the centre of gravity of the body will fall behind the fractured vertebral body, so that in the upright position the body weight will tend to correct the deformity. Repair takes a very long time in the vertebral column, so that the cast will have to be worn for four months and perhaps for six. The length of time is gauged by the X-ray appearances. In the cervical region dislocations are sometimes replaced by traction and manipulation under

forearms supinated (Thorburn's position). This is because the fifth cervical segment supplies the abductors of the shoulder, the flexors of the elbow and the supinators (cp. Erb's paralysis, page 200).



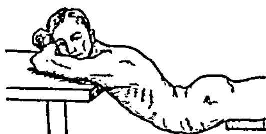
Thorburn's position. *Lesion of 6th cervical segment.* Abduction of shoulder joints, flexion of elbow joints and supination.

When the lesion is in the dorsal region, the lower part of the rectus may be paralysed whilst the upper part contracts, so that at every expiration the umbilicus is drawn upwards. Pressure on nerves in the intervertebral foramina may not only cause severe pain in the abdomen but may give rise to abdominal rigidity, thus causing a considerable resemblance to an abdominal injury. There is a band of hyperaesthesia at the upper level of the anaesthesia. This level is important as indicating the situation of the injury. If the lumbar enlargement is crushed there will be paralysis and atrophy of the muscles supplied from this region and a flaccid bladder with relaxed sphincters, so that there is not retention but a continuous dribble of urine. Cauda equina lesions resemble injuries of the peripheral nerves. Partial lesions of the cord are recognised by the paralysis being incomplete, some of the muscles escaping, and by the fact that all sensation is not lost. The anaesthesia may be confined to certain segments or there may be loss of touch whilst the patient can still appreciate changes of temperature and pain.

Prognosis.—Unless the cord is completely and irrevocably crushed right across there sets in, after a time, a process of gradual recovery, though it may not proceed far. The outlook is always exceedingly grave. With a complete transverse lesion of the cervical cord death usually comes in a few weeks; often in a few days from an ascending myelitis proceeding upwards from the site of the injury and reaching the phrenic centre. In complete dorsal transverse lesions the patient may survive for years. Patients with cord injuries die from respiratory complications owing to the paralysis of the muscles of breathing; from sepsis spreading from bed-sores or from septic pyelonephritis. Patients with a spinal fracture should be moved with great care, for the slightest further displacement of the bones may cause more damage to the delicate nervous tissue. Some surgeons recommend transport in the prone position, but with a patient lying on his face

there is sometimes difficulty in breathing. This must be provided for by props under the shoulders.

Treatment.—The treatment of injuries of the spine when there is cord damage is not agreed upon by all surgeons, but when the cord is not involved it consists in placing the spine in hyperextension and maintaining this position until the repair has taken place. In *compression fractures of the body of a vertebra or fracture-dislocations in* the dorsal or lumbar region reduction is performed as follows. No anaesthetic is given beyond ¼ grain of morphine. The patient is then placed face downwards on a table and brought over the edge as far as his groins. His arms and shoulders are supported by another table at a slightly higher level. In this position, as the trunk sags,



Fractured spine. *Position of patient for application of plaster.* The jacket must reach from the symphysis pubis to the top of the manubrium in front: up to the angles of the scapulae behind.



Plaster jacket for fractured spine: it extends up to the clavicles in front and down to the symphysis pubis.

the deformity corrects itself. A plaster jacket is put on from the level of the groins to the shoulders. It is cut away over the abdomen. A pressure sore is likely to occur over the dorsilumbar spines, so a piece of felt is placed in this region before the plaster is applied and the casing is cut away here afterwards. As soon as the plaster is hard the patient may sit up, and in a week he may walk. If the spine is sufficiently hyperextended the centre of gravity of the body will fall behind the fractured vertebral body, so that in the upright position the body weight will tend to correct the deformity. Repair takes a very long time in the vertebral column, so that the cast will have to be worn for four months and perhaps for six. The length of time is gauged by the X-ray appearances. In the cervical region dislocations are sometimes replaced by traction and manipulation under

anaesthesia, but of course great care must be taken not to cause damage to the cord in the process. Often they will be spontaneously reduced if the patient be allowed to lie in bed on his back with a pillow under his shoulders so that the head falls back and by its weight accomplishes the reduction. This is true also of the spontaneous dislocations of the atlas and those which accompany a fracture of the odontoid process. In these cases it is perhaps wise to encase the shoulders and neck in a plaster which controls the head also, by a band going round the forehead, unless very capable and reliable nurses ensure that, in no movement of the patient, flexion of the neck shall occur, when immobilisation between sandbags is sufficient. The repair of the ligaments around the articular processes is strong enough in six weeks for the patient to be allowed up. The odontoid process has not to carry any weight.

When there is paraplegia most surgeons maintain that no good can be done by an operation. The general attitude adopted is to wait and see if any recovery should take place, and if it does, only to operate when the recovery process comes to an end. This line of action is quite illogical. In the early stages of spinal injury spinal shock may make it impossible to form any reliable estimate of the real and actual irreparable damage to the cord. It is also known that regeneration of nerve fibres does not take place in the spinal cord and that pressure on the cord without division of nerve fibres will cause irrecoverable loss of conduction power within five days. It is useless then to do a late operation to relieve pressure unless it is believed to be due to the increase of callus or the formation of an arachnoid cyst. Whilst many surgeons believe that the best that can be done for paraplegic cases is fixation in plaster in the hyperextended position, others, influenced by these considerations, counsel laminectomy at the earliest moment at which the patient is adjudged capable of withstanding the operation, and anyhow within four days or not at all. They believe that laminectomy will bring about a useful decompression in the same way that it does in head injuries. A considerable opening is made in the dura and it is left open, whilst, if the cord seems very much swollen and under tension, longitudinal incisions may be made in the posterior columns. Whether projecting bone should be chiselled away or not must be left for decision at the time. Since the patient is anaesthetic below the level of the laminectomy, it is only necessary to anaesthetise him above this level for which local injection of novocain may be quite sufficient. At the end of the operation the patient should be put into a plaster in the hyperextended position.

In the nursing of these patients the greatest precautions have to be taken to prevent the formation of bed-sores. For the retention of

urine immediately following a spinal injury catheterisation should not be done. It is too likely to introduce a fatal urinary infection. Temporary relief may be given by one or more punctures with a narrow-bore needle such as that used for a lumbar puncture. The urine is aspirated with a syringe. In all cases of spinal injury with retention a suprapubic opening, in which is placed a self-retaining catheter, should be made as soon as possible. The opening should be high up in the bladder and the tube emerge from the surface mid-way between the umbilicus and symphysis pubis. If bladder function returns the fistula is allowed to heal. The surgeon should not take too hopeless a view of the prospect of recovery of function in the early stages, for spinal shock may be weeks before it disappears and recovery of bladder function may take place after many weeks, and of sensory and motor power after many months.

In late cases sometimes a laminectomy will cause improvement by the evacuation of an arachnoid cyst. In cases of injury to the cauda equina there is no need for hurry, because the strands of the cauda degenerate and regenerate just as do peripheral nerves.

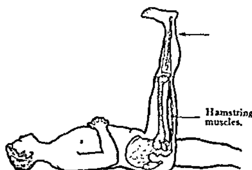
Sacro-Iliac and Lumbo-Sacral Strain

Pain in the lower part of the back is a rather common complaint and may be due to a variety of causes. It may be symptomatic of Pott's disease of the spine, tuberculous sacro-iliac disease, prolapse of a nucleus pulposus, spondylitis deformans or fibrositis, that is, inflammatory lesions of the attachments of the muscles. Sometimes the pain is referred from some viscus, particularly the female genital organs, or in men the seminal vesicles or prostate; or the colon may be at fault. When all these causes have been excluded there remain sprains of the lumbo-sacral or sacro-iliac joints.

A great deal has been written about sprains of these two joints and the possibility of there being small bony subluxations in this situation. Slight displacements have been accepted as the underlying lesion because manipulations have frequently been found to cause a disappearance of the pain. In the X-ray, however, lumbo-sacral and sacro-iliac displacements are extremely rare, and the relief from manipulation may be attributed to the tearing of adhesions which limit movement and are painful.

The diagnosis of sprains of these joints is made by applying tests which subject these joints to strain. The movement which takes place at the sacro-iliac joints is a small one. It is a rotatory movement round a transverse axis. If the patient lies on his back and his thigh, with the knee extended, is strongly flexed, the hamstring muscles

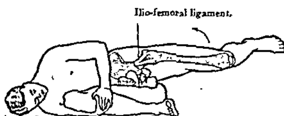
pulling on the tuber ischii will tend to rotate the ilium backwards on the sacrum and will give rise to pain. This test also stretches the sciatic nerve and is positive in cases of sciatica; but in sciatica the nerve itself will be tender on palpation. The pelvis can be made to rotate in the opposite direction. The patient lies on his side and flexes the good thigh on the abdomen and holds it in acute flexion by clasping his hands round his knee. The other thigh is then hyper-extended



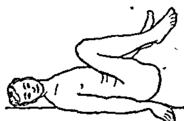
Rotation of pelvis on sacrum backwards by pull of hamstring muscles on the tuber ischii.



Rotation of pelvis on sacrum forwards by the pull of the rectus femoris muscle on the anterior inferior iliac spine.



Rotation of pelvis forward on sacrum by pull of the ilio-femoral ligament.



Strong flexion of both hips causes pain in lumbo-sacral disease.

with the knee flexed. This will not stretch the sciatic nerve but it will, by pulling through the Y-shaped ligament of Bigelow, rotate the ilium forwards at the sacro-iliac joint and give rise to pain. Or if the patient lies on his face, it will be found that the heel cannot be approximated so close to the buttock on the side of sacro-iliac sprain as on the normal side, but when an attempt is made to force this movement, pain is caused, the ilium in this case being rotated by the tense rectus femoris attached to the antero-inferior spine. Rectal examination sometimes reveals tenderness in front of the sacro-iliac joint and, posteriorly, there may be a similar area of tenderness. The lumbo-sacral cord which passes over the sacro-iliac joint may share in any inflammatory reaction in the neighbourhood and so there may be pain down the thigh. Flexion of both thighs on the abdomen causes pain in a lumbo-sacral strain but not in a sacro-iliac injury.

The foramina between the sacrum and the fifth lumbar vertebra are the smallest of the intervertebral foramina, yet they transmit the

largest of the spinal nerves, which with their surrounding plexus of veins almost fill these spaces. Behind the canal is the intervertebral articulation, in front and to the inner side is the intervertebral disc, behind and to the outer side are the lumbo-sacral and ilio-lumbar ligaments. An inflammatory exudation due to a sprain of these ligaments or the intervertebral joint or protrusion of the nucleus pulposus may press upon the spinal nerve in the foramen and give rise to symptoms.

In acute sacro-iliac or lumbo-sacral sprains the patient should be kept in bed and traction, with a 6 to 10 pound weight, applied to each leg. Support beneath the lumbar spine often makes the patient comfortable. At the same time, heat applied by a diathermy machine seems to cause resolution of the inflammatory products. Epidural injections, that is, the injection through the sacral canal, but outside the dura *mater, of saline solution sometimes give relief.*

In slighter cases and when acute cases are well enough to get up, strapping support is useful. Strips of strapping, which pass from just within one anterior superior spine of the ilium round the body in an oblique direction downwards towards the great trochanter on the opposite side, should be applied, crossing and overlapping each other. Three strips running in each direction are usually sufficient. Manipulations of the lumbar spine and sacro-iliac joint are also sometimes successful. Manipulation consists in forcible flexion and extension of the lumbar spine and in forcing the ilium backwards at the sacro-iliac joint.

Division of the tensor fasciae femoris has been found sometimes to relieve the pain, but it is not clear exactly how it does so.

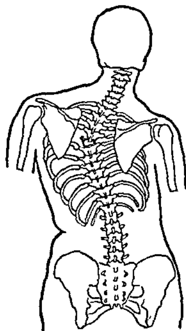
In bad cases a Hibbs *spinal fusion of the fifth lumbar vertebra* to the sacrum has been strongly recommended. After the operation the patient is kept recumbent for 8 weeks, and a back brace is worn for 4 or 5 months. An essential for success is that bony union should be firm and secure.

Scoliosis

Scoliosis is the name given to a permanent lateral deformity of the spine. Several varieties are recognised:

1. *Congenital.*—*Some children are born with a half vertebra in* place of a complete one. This extraordinary defect causes a very pronounced and very intractable form of lateral deformity. As a rule the best thing to do is to order a supporting jacket, but there have been a few reports of excision of the defective vertebra. The operation seems to have been associated with much shock and to have a high mortality.

2. *Secondary.*—If one leg happens to be shorter than the other the pelvis becomes tilted and the spine perforce assumes a lateral curve. This will happen with tuberculous disease of the hip, dislocation of the hip or shortening of the leg from disease of the knee joint or paralysis. Other causes of secondary scoliosis are the falling-in of the chest on one side from an empyema and the contraction of the neck muscles in torticollis.



Congenital scoliosis due to an extra half vertebra.

3. *Paralytic.*—The most extreme forms of lateral curvature occur when the muscles on one side of the spinal column are paralysed from some disease of the nervous system such as anterior poliomyelitis or syringomyelia. The most acute bends take place and although the curves may be straightened out if the patient is seen in the earlier stages, there is no possible way of maintaining the correction, at least in the ordinary extensive case. Supporting jackets are the only means of treatment, inefficient as they are as splints. Very occasionally, in the less extensive deformities, the fixation of the bony vertebrae together by a bone graft should be considered.

4. *Adolescent.*—Adolescent scoliosis is by far the commonest variety of lateral curvature. It begins typically at about the age of 7 or 8 years. The bending begins in one part of the spine, usually the dorsal, and with the convexity to the right. As the child's balance is upset by this deviation there soon appear secondary curves above and below the primary one, by which equilibrium is restored. With this there occurs a rotation of the vertebral column which will be referred to later. Clinically such a case would be described as having a primary convexity to the right in the dorsal region with secondary curves in the cervical and lumbar parts of the spine with a rotation of the right chest backwards (for in an established deformity of this kind with secondary curves the vertebral bodies are always rotated towards the side of the convexity at the point of maximum curvature).

The pathological anatomy is important. When the deformity has lasted for some time, changes in the conformation of the vertebrae take place. Those at the summit of the curve become wedge-shaped whilst those above and below become rhomboidal. Owing to the pull of the muscles in the rotated position, the laminae and spines are distorted and gradually grow asymmetrical. The intervertebral

discs are compressed on the concave side where the bony bodies are nearly in contact, and wider on the other side, the nucleus pulposus being squeezed towards the convexity. The thorax becomes very asymmetrical. On the side of the concavity the angles of the ribs become much smaller whilst on the other side the angles open out, and the ribs which are farther apart are much broader. The projecting thorax on the side of the convexity behind corresponds with a flattening of the chest on that side in front, and the sternum is pulled towards that side. The result of all this is that there is greatly diminished room in the thorax on the concave side, which is an embarrassment to the proper development and aeration of the lung. The heart and large blood-vessels may also show some distortion. The scoliotic asymmetrical pelvis, an adaptation to the abnormal distribution of the body weight, is well known as a cause of difficult labour.

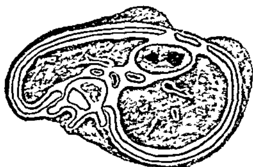


Diagram to show how the heart is displaced and the lungs distorted by the rotation of the spine in a severe scoliosis.

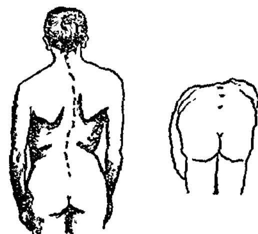
The aetiology of the condition is by no means clear, but it does seem that a weakness of the muscles is the immediate cause. It is true that a disease such as rickets which makes the bones soft will also lead to a scoliosis, but here again there is a great weakness and flabbiness of the muscular system. The relation of the nervous system to adolescent scoliosis is not so evident. We have seen how paralysis will cause lateral curvature, and it is quite possible for a mild attack of infantile paralysis to pick out small groups of muscles and weaken them so that the co-ordination of the muscular effort to maintain the erect posture is upset. But there is no evidence that the long spinal muscles or the so-called intrinsic short spinal muscles, or such muscles as the trapezius, latissimus dorsi or pectoralis major, are ever asymmetrically weakened or degenerated in adolescent scoliosis. Indeed there is no need to postulate any such paralysis. The erect attitude has to be maintained by a quite considerable muscular effort. If from weakness, inherent, or due to a general illness the muscles of the back tire, the spine is bound to sag into a lateral curve. Because each vertebra has three points of support, at the body and the two articular processes, whilst the spinous processes are bound together with the somewhat inelastic spinous and interspinous ligaments, lateral bending can take place only if some rotation takes place at the same time. Radiographs of the normal laterally flexed spine clearly demonstrate

the rotation of the vertebral bodies towards the convex side of all curves. The curvature due to muscular weakness is not a scoliosis if,



The curves the spine assumes when writing at too high a desk.

by an effort, the deformity can be corrected; but when it has persisted for some time the muscles and ligaments, on the side of the concavity, become permanently contracted. Then it has become fixed beyond *the patient's power of correction; it is a scoliosis.* The habitual assumption of an asymmetrical position of the spine in some occupation which uses the muscles *on the one side much more than* on the other, and even the constant sprawling attitude with the right arm spread out on the desk which children are apt to assume at school, have also been accredited with the responsibility of initiating a scoliosis. *Nevertheless there are some victims of this deformity who are not weakly children; on the contrary they* are sturdy with good muscular development. They show no signs of paralysis or inco-ordination. For these there must be some other explanation, and it is suggested that there may be some inco-ordination in the rate of growth of the bones and soft tissues. If the spinal muscles failed to grow a



Scoliosis. Note raising of right shoulder and scapular angle, and the large space between the body and *arm on the same side.* On the right the rotation backwards of the right thorax seen when the patient bends forwards.

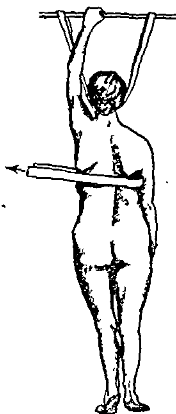
column the spine would be forced to accommodate itself by bending. The deformity would be initiated only during the period of growth, and it would tend to persist and increase so long as growth went on. This is indeed true of scoliosis.

The clinical features are very evident when the patient is looked at from behind. There are first the primary and secondary curves, but these as marked out by the spinous processes are not as pronounced as the real curves of the vertebral bodies because of the rotations of the spinous processes towards each concavity. In a typical case with the primary convexity to the right in the dorsal region the right shoulder is raised and the right scapula higher than the left. There is a deep cleft above the right hip corresponding to the lumbar concavity, and there is a great difference between the shapes of the space between the arm and the trunk on the two sides of the body. The rotation is observed best by looking horizontally along the back whilst the patient bends downwards in the effort to reach the toes. Then the ribs on the right side will be seen to form a bulge backwards. On the anterior aspect the left breast will be seen to project forwards more than the right. It is a curious fact that the degree of rotation varies very much in different individuals and does not seem to bear a close relation to the amount of lateral bending, so that sometimes the lateral deviation may be overlooked and the attention be fixed on the prominence of the chondrocostal junctions caused by the backward rotation of the chest on the same side. In every case of scoliosis, of course, the legs should be measured, and also any other cause of a secondary curve searched for.

In some early cases the direction of rotation of the spine is the reverse of that described. In these early cases there is usually a single long curve with its convexity to the left, and when the child bends down it is seen that the right thorax projects backwards. This deformity has been described as a postural scoliosis as opposed to the structural scoliosis described above. As the deformity increases it takes on the character of structural scoliosis. That is, either the curvature or the direction of rotation are reversed.

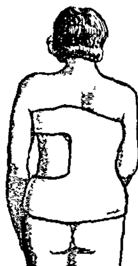
Treatment.—The treatment of scoliosis is extremely difficult. In early stages, particularly in the postural cases, the disease may be cured, but in the established structural variety the most that can be hoped for is that the deformity may become stationary. Too often even this limited objective cannot be attained. The difficulty is that the deformity is progressive in tendency as long as the individual continues to grow. This is understandable if there is an actual difference in the rate of growth of the skeleton and the soft parts, as suggested above. It is therefore evident that treatment must be of

long duration if it is to be effective, and indeed must be continued until the patient is fully grown. It need not be very intense during the whole of this time, but periodical observations should be made to ascertain whether a relapse, which is so common, has occurred.



Straightening out of the bends by suspension and lateral traction for application of a plaster jacket.

In all cases the general health of the patient should be built up, and if there are any measures which are likely to assist in this, such as the removal of diseased tonsils, this should be done. The next indication is to relieve the spine of as much vertical pressure as possible. Therefore the period which the patient spends in bed should be prolonged and he should be made to lie rather than sit down during periods of rest. It is a good plan to insist on the child lying on his back for two hours every afternoon. At the same time exercises which do not fatigue him should be recommended, particularly those which have been devised to strengthen those muscles on the convex sides of the curves. They are much better done under the supervision of a qualified masseuse and in a class with other scoliotic children. In some cases manipulations to stretch the contracted muscles and ligaments are an advantage. They may be carried out in combination with the gymnastic exercises. By such manipulations quite pronounced curves may be loosened so that when the patient suspends himself by the hands the spine will be straight. But no muscles can be made strong enough to maintain this corrected position, for in it the vertebral bodies are standing as it were on their lateral edges.



Plaster jacket for scoliosis.

In the bad structural cases some sort of support is employed in association with manipulation and exercises, or following them. In the latter case plaster of Paris is used. The patient is suspended in the position shown in the neighbouring figure so that by the position of the arms the maximum correction is obtained, or he may be slung in a hammock in a similar fashion. A plaster jacket

is then applied which must take a firm support from the pelvic girdle. Large windows are cut in the jacket opposite the flattened areas of the chest both in front and behind. This is to allow the thorax to bulge as correction and growth proceed. Such a jacket with renewals must be worn for at least a year, after which gymnastic exercises combined with rest from weight-bearing must be resumed whilst a supervision must be maintained until the patient ceases to grow. Before making a plaster jacket some surgeons recommend treatment on a frame with traction on the head and pelvis such as is used in Pott's disease, for 4 to 8 weeks. After the plaster jacket has been discarded a celluloid and steel corset is sometimes of advantage. Such supports may be used in less severe cases without the preliminary employment of plaster.

Finally, in the most severe cases fixation of the spine by bone grafting has been carried out. Theoretically there does not seem to be much to recommend this method, chiefly because of the very great length of the spine, which would seem to require fixation in order that the operation should be effective. There have, however, been several reports in which surgeons have stated their satisfaction with the operation.

Spondylolisthesis

Spondylolisthesis is a partial dislocation of the fifth lumbar vertebra forwards upon the sacrum. It is a condition seen nearly always in adults and may be due to a severe injury or to an occupational strain, obesity or pregnancy. The patient complains of backache on standing and pain referred to the sacro-iliac region of the thighs. There may also be weakness, numbness or tingling in the legs.



Skiagram of spondylolisthesis.

The disease is easily diagnosed because of the abnormal hollow in the lumbar region just above the sacrum, and muscle spasm, so that the erectores spinae stand out strongly on each side of the vertebral spines. This spasm makes the back stiff, which is easily demonstrable on bending forwards. The sacrum appears to be more prominent than normal. On rectal examination there is a hard fixed mass in front of the top of the sacrum. The symptoms are relieved when the patient lies down.

The displacement may cause an obstruction to labour. An X-ray will show how much the vertebra has shifted forwards and it will very often reveal either fractures of the lamellae or a congenital deficiency. Spina bifida occulta is a quite common association.

Treatment consists in traction on the spine, the patient being on his back for 6 weeks. This is brought about by applying strapping to both limbs and pulling upon them by a weight, whilst the foot of the bed is raised. When the patient is allowed up he should be provided with a supporting corset. A more effective permanent treatment is to cause fusion of the lower lumbar vertebrae with the sacrum. This is done through a mid-line incision which exposes the three lower lumbar vertebrae and the upper part of the sacrum from which the spinal muscles are detached. The posterior portions of the lamellae are chiselled off and are made to bridge the gaps between them. The spines are bared and grafts, taken from the tibiae, are fixed to the lumbar vertebrae and sacrum. Spinal fusion eliminates the necessity for the use of a corset.

Prolapse of the Nucleus Pulposus

Occupying the posterior two-thirds of the intervertebral discs are the remains of the notocord. This is spherical in shape, myxomatous in nature and is under tension, so that the vertebrae in their movements on one another roll around a hard ball of fluid. Surrounding the nucleus pulposus is the confining annulus fibrosus. On the opposing surfaces of the vertebral bodies are cartilaginous plates. This plate may become fissured by injury and then the nucleus pulposus may escape into the cancellous tissue of the vertebral body. Surrounding the escaped nodule in a vertebral body sclerosis takes place so that in an X-ray the excavation of the bone is very evident, being surrounded by a layer of denser bone. Usually the change is seen best in a lateral view.

More often the nucleus bulges backwards into the spinal canal when by pressure upon nerves it causes symptoms. The commonest nucleus to be dislocated is that between the fourth and fifth lumbar vertebrae; almost as frequent is a dislocation of that between the last lumbar vertebra and the sacrum. Very often the protrusion is to one side near the intervertebral foramen, in which case the spinal nerve is pressed upon and the symptoms are unilateral. If the projection is more central, several nerves of the cauda equina may become involved. The symptoms are then bilateral in distribution. When the nucleus pulposus has escaped from its proper position it

loses its characteristic consistency. It becomes fibrous and perhaps cartilaginous in nature.

The onset of symptoms may date from some obvious strain of the back, but such a history is often lacking. Dislocation occurs usually in young adults. The first symptom is pain in the back referred to the lumbo-sacral region. This pain may be present for weeks or months and then abate for a time only to appear again. It certainly comes on with standing and fatigue. Then, in lateral protrusions, the pain spreads to the area of distribution of the sciatic nerve, in which a neuritis is set up. There are tenderness along the course of the nerve, increased pain on stretching it, and later slight weakness of dorsiflexion of the foot with diminution of the Achilles jerk. There may be a slightly lessened sensation on the inner side of the leg and foot when the disc between the fourth and fifth lumbar vertebrae is concerned, on the outer side when it is the disc between the last lumbar vertebra and the sacrum. There is a little lumbar scoliosis, the convexity being on the side the disc prolapses.

When the nucleus projects more directly backwards the sciatica may be bilateral, pain is felt generally in the pelvis and there may be pain and irritability in the bladder and rectum.

The diagnosis is made by reviewing the whole collection of symptoms and is not always easy, but, in the lateral protrusions the following procedure may be of help. The patient lies on his back with his legs rigidly extended. The surgeon grasps the normal ankle and pulls the limb downwards, whilst at the same time he pushes firmly upwards on the sole of the affected limb. After a short latent period the patient feels intensified pain which is relieved when the action is reversed, the normal sole being pushed upwards and the affected leg pulled downwards. This effect depends upon the fact that the manipulation causes the lumbar spine to become convex towards the normal side which leads to compression of the intervertebral discs on the opposite side, a movement which makes the prolapsed nucleus extrude still further and with more force against the nerve root.

When the prolapse is central the patient lies on his back with his legs from the knees dangling over the end of the table. This position compresses a backward dislocation and, after a latent period, increases the pain. The pain is relieved by flexing the thighs. A lateral projection may also give this test.

A skiagram may show a narrowing of the intervertebral space, but it must be remembered that the space between the fifth lumbar vertebra and the sacrum is normally narrower than the other lumbar spaces. The injection of lipiodol is not recommended, nor is the

injection of air which causes intense headache. Neither procedure is very reliable.

It may be difficult to distinguish prolapse of a nucleus pulposus from lumbo-sacral or sacro-iliac strain. One difference is that in these conditions pain is caused by passive flexion and rotation of the lumbar spine.

In the cervical region again there is often a history of trauma and then neuralgic pains are felt at the base of the neck, tip of shoulder and down the arm as far as the elbow. The discs affected are usually those below the fifth or sixth cervical vertebra, so it is the sixth or seventh nerve which is pressed upon. There is a good deal of stiffness of the neck, and just as in prolapse of the lumbar discs the pain is increased by coughing or sneezing. Weakness of the biceps muscle points to a sixth nerve lesion and weakness of the triceps to pressure on the seventh. The corresponding biceps or triceps jerk may be diminished. Tilting the head to the affected side increases the pain or sets it up. If, in this position, the head is pressed upon the pain is greatly intensified. Tilting the head away from the lesion gives relief. A neoplasm of the spinal cord may produce exactly similar symptoms. In the scalenus anticus syndrome the pain and parasthesia are referred to the eighth cervical and first dorsal segments and there is often an accompanying vascular component due to pressure on the subclavian artery.

In the treatment of lumbar herniations prolonged rest in bed may bring relief and cure.

In inveterate resistant cases an operation is indicated. As a rule the ligamentum subflavum at the affected site is cut away and the adjacent margins of the two laminae nibbled off. This is sufficient to show the projecting metamorphosed nucleus and allow its removal. Some surgeons recommend a much more extensive laminectomy because the exact level of the protrusion may not be known beforehand, and this plan allows of a more extensive exploration.

A similar operation is performed for cervical protrusions.

Adolescent Kyphosis

In this condition there is a gradual even curvature of the spine in the cervico-dorsal region which is noticed first in early adolescence. The pathological nature of the disease is rather obscure, but it has features in common with those of pseudocoxalgia. For there is failure of development of the epiphyseal ring and fragmentation, with changes in the underlying bone. Punched-out areas and the fragmentation are best seen in the lateral X-ray, which also reveals a

narrowing of the intervertebral discs and prolapse of the nucleus pulposus into the vertebral body. Clinically there is simply the deformity without any pain.

Treatment consists in exercises to strengthen the muscles of the back and the lessening of the weight-compressing force on the bodies of the vertebrae. This, of course, is best accomplished by dorsal recumbency in the hyperextended position. In milder cases some of the strain may be taken by a well-designed back brace. At the same time the patient should pass two or three hours of the day lying on his back.

Acute Osteomyelitis of the Spine

Acute osteomyelitis of the spine is rather a rare condition. As with osteomyelitis elsewhere the infection is usually due to the staphylococcus and is seen before the age of 20. It does, however, occur in adult life. The infection begins perhaps more commonly in the lamina than in the body of the vertebra, and in the lumbar region more than in other parts. The disease begins suddenly with acute *pain in the back and a rise of temperature. There is rigidity of the* back. A carbuncle or boil may have preceded the onset. Abscess formation is the rule and the abscess points forwards or posteriorly according as the disease begins in a body or a lamina. Thus it appears in the pharynx, in the mediastinum, in the psoas sheath, in the pelvis or in the back. In the lumbar region it may be thought to be a perinephric abscess coming from the kidney and its true origin be overlooked. The inflammatory process may spread to the intervertebral joints, enter the spinal canal through the intervertebral foramina and cause paraplegia through pressure or myelitis. A persistent sinus may be due to the presence of a sequestrum. It may be impossible to heal a cavity in the body of a vertebra by surgical means partly because of difficulty of access but also because the sides of the cavity cannot be brought into contact, so that the patient may be condemned to a permanent septic sinus and ultimately succumb to amyloid disease.

As soon as the disease is suspected treatment with penicillin should be begun. In this way necrosis of bone with sinus formation may be prevented. Without penicillin the outlook is very grave, for about one-half the patients die.

Chronic Septic Osteomyelitis of the Spine

This rather uncommon condition must be mentioned because in the early stages it resembles Pott's disease. There are pain in the

injection of air which causes intense headache. Neither procedure is very reliable.

It may be difficult to distinguish prolapse of a nucleus pulposus from lumbo-sacral or sacro-iliac strain. One difference is that in these conditions pain is caused by passive flexion and rotation of the lumbar spine.

In the cervical region again there is often a history of trauma and then neuralgic pains are felt at the base of the neck, tip of shoulder and down the arm as far as the elbow. The discs affected are usually those below the fifth or sixth cervical vertebra, so it is the sixth or seventh nerve which is pressed upon. There is a good deal of stiffness of the neck, and just as in prolapse of the lumbar discs the pain is increased by coughing or sneezing. Weakness of the biceps muscle points to a sixth nerve lesion and weakness of the triceps to pressure on the seventh. The corresponding biceps or triceps jerk may be diminished. Tilting the head to the affected side increases the pain or sets it up. If, in this position, the head is pressed upon the pain is greatly intensified. Tilting the head away from the lesion gives relief. A neoplasm of the spinal cord may produce exactly similar symptoms. In the scalenus anticus syndrome the pain and parasthesia are referred to the eighth cervical and first dorsal segments and there is often an accompanying vascular component due to pressure on the subclavian artery.

In the treatment of lumbar herniations prolonged rest in bed may bring relief and cure.

In inveterate resistant cases an operation is indicated. As a rule the ligamentum subflavum at the affected site is cut away and the adjacent margins of the two laminae nibbled off. This is sufficient to show the projecting metamorphosed nucleus and allow its removal. Some surgeons recommend a much more extensive laminectomy because the exact level of the protrusion may not be known beforehand, and this plan allows of a more extensive exploration.

A similar operation is performed for cervical protrusions.

Adolescent Kyphosis

In this condition there is a gradual even curvature of the spine in the cervico-dorsal region which is noticed first in early adolescence. The pathological nature of the disease is rather obscure, but it has features in common with those of pseudocoxalgia. For there is failure of development of the epiphyseal ring and fragmentation, with changes in the underlying bone. Punched-out areas and the fragmentation are best seen in the lateral X-ray, which also reveals a

myelitis), or in adults perhaps near the anterior or posterior surface. Any part of the spine may be affected, but it is more common in the lower dorsal region than anywhere else. As elsewhere, the tuberculous granulation tissue which comes to fill the cancellous spaces leads to an absorption of the calcium salts and so to a softening of the bone and a loss of opacity to the X-rays. Reaching the intervertebral disc this structure is soon invaded and destroyed and the process extends perhaps to another vertebra. The disease may be confined to two or three vertebrae or it may extend over a considerable length of the spine. The softened bodies collapse with the weight of the body so that the characteristic angular kyphosis is produced. The loss of definition of the bones, the collapse of the bodies and the disappearance of the intervertebral spaces are the diagnostic features in the X-ray photograph. With the collapse of the vertebral body there may be an actual dislocation of the upper healthy part of the spine upon the lower. When the disease is in the upper half of the dorsal region the upper part of the spine dislocates forwards, when in the lower half it passes backwards.

A cold abscess is likely to form. Such abscesses are common on the anterior surface of the bodies of the vertebrae; if they spread round to the side they tend, when they meet the intervertebral nerves, to accompany these nerves until they find some path leading to the surface. The kyphosis causes the hunchback, whilst the collapse of the vertebrae also allows the ribs to fall together. The vertical diameter of the thorax is lessened, it becomes barrel-shaped. This embarrasses the movements of the heart and lungs and predisposes to respiratory disease and is one of the reasons why so few old hunchbacks are seen walking about the world. They die young. There is little or no new bone formation in spinal caries. Repair takes place by the union of the healthy body above with the healthy body below the lesion, unless of course the abscess has reached the surface, discharged and become secondarily infected with staphylococci, when there will be new bone formation.



Healed spinal caries in dorsal region showing extreme kyphosis.

The spinal cord may be involved in the disease usually by pressure, sometimes by oedema from venous obstruction, sometimes by an actual tuberculous osteomyelitis. Pressure upon the spinal cord is rather uncommon as a complication, and at first sight it is difficult to see why the sharp projecting angle formed by the posterior surfaces

back, tenderness and rigidity. The patient is not ill as in the acute disease, and no abscess forms. There may have been a preliminary boil. An X-ray examination will show a diminution of the intervertebral space and slight irregularity of the edges of the adjacent bodies. Very soon new bone is thrown out and within three months fusion of the bodies may occur. This rapidity of the curative process distinguishes it from Pott's disease.

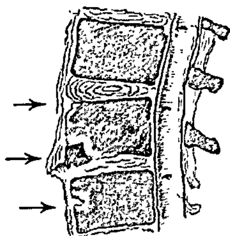
While the disease lasts it should be treated as Pott's disease.

Typhoid Spine

This is simply chronic typhoid osteomyelitis of the spine which comes on at a variable interval after an attack of typhoid fever. There are pains in the back, tenderness and rigidity and so much softening that there may be a kyphosis or a lateral curvature. Recumbency in the early stages followed by the use of a back brace when the patient can get about are all that is called for. The outlook is good.

Tuberculous Spondylitis (Pott's Disease)

This is a disease pre-eminently of childhood though it also occurs in adults. The bacilli reach the spine by the blood-stream into which they have gained access from some other focus, usually a tuberculous



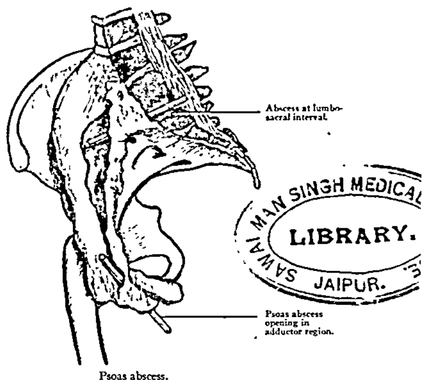
Three areas of tuberculous osteitis. The upper two are in the most characteristic situations. Note the white caseous infiltration of the bone.



Skiagram of Pott's disease of spine. Two vertebrae and the intervening intervertebral disc are affected.

lymphatic gland, so that the disease is a secondary one and the more serious as we must suppose the patient's resistance to have broken down twice. The disease begins in the cancellous tissue of the vertebral body near the upper or lower surface (tuberculous osteo-

and raising the body by grasping the ankles. This method of examination, by failure of the hip joints to hyperextend, will also demonstrate spasm of the psoas muscle, which takes place when there is a psoas abscess. In dorsal disease above the eleventh vertebra the anterior abscess bulges under the anterior common ligament and pushes the pleura forwards. It may be recognised by dulness to percussion and distant breath sounds. If it passes round to the side of the vertebra and reaches the intercostal nerves, it may pass backwards with the posterior cutaneous branches and appear in the back, or continue along the intercostal nerves and appear with the lateral



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Psoas abscess.

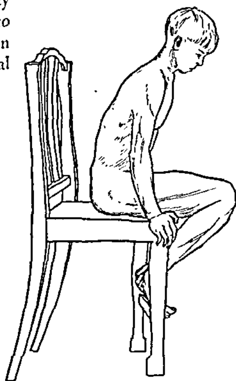
cutaneous branches on the side wall of the thorax or with the anterior cutaneous branches and form an abscess close to the sternum. Below the eleventh dorsal vertebra an anterior abscess is likely to pass downwards under the arcuate ligament and enter the psoas sheath. It infiltrates the whole of this sheath and the muscle tissue itself and perhaps will pass backwards to the body surface through the triangle of Petit. When it reaches the inguinal ligament it usually pauses in its spread and for a time forms a bulge here before resuming its path beneath the ligament into the thigh. A psoas abscess is detected by palpating it at the inner edge of the psoas from the abdomen, by obtaining fluctuation with one finger above and one below Poupart's ligament when the abscess has reached the thigh, and by demonstrating the spasm of the psoas with the patient on his face as

of the bodies does *not more often* press upon the cord and cause damage. It must be remembered that the bony column is shortened by the collapse of the bodies, and so the cord, fixed as it is by the spinal nerve roots to the column above and below the diseased area, is bent in a loop backwards away from the projecting angle. As a rule, when paraplegia occurs, it is in the dorsal region, because here the spinal canal is narrowest.

Symptoms and Signs.—(1) THORACIC REGION: It is first noticed that the child is less active than is his wont, that he plays less freely *with his companions and appears to be easily tired.* He *will* not jump or perform any movement which may jar the spine. Soon he begins to complain of pain which is felt in the back and along the intercostal



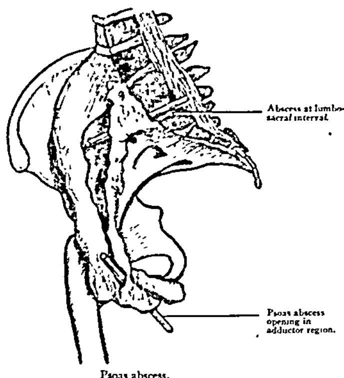
Dorsal spinal caries. Climbing up the thigh after picking up an object on the floor. Note the break in the curve of the back.



Dorsal spinal caries. A characteristic position: supporting the weight with the hands.

nerves to the abdomen so that he has stomach-ache. *If* the *child* be made to bend down to touch his toes it will be seen that the *normal regular curve of the spine is broken* at the site of the disease; there is either a slight angle perceptible or over a short distance the curve is replaced by a straight line. Next it will be noticed that the patient will reach down to the floor by bending his knees. Also when he does stoop down he will very likely regain the erect position by climbing up his *legs with his hands. Palpation of the back will* reveal the projection of a spinous process, and on percussion one or more processes will be invariably tender. Rigidity of the back can be demonstrated in small children by placing them face downwards

and raising the body by grasping the ankles. This method of examination, by failure of the hip joints to hyperextend, will also demonstrate spasm of the psoas muscle, which takes place when there is a psoas abscess. In dorsal disease above the eleventh vertebra the anterior abscess bulges under the anterior common ligament and pushes the pleura forwards. It may be recognised by dulness to percussion and distant breath sounds. If it passes round to the side of the vertebra and reaches the intercostal nerves, it may pass backwards with the posterior cutaneous branches and appear in the back, or continue along the intercostal nerves and appear with the lateral

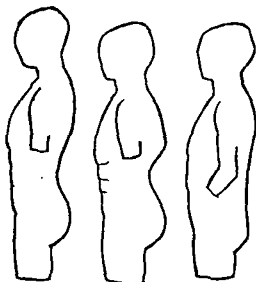


Psoas abscess.

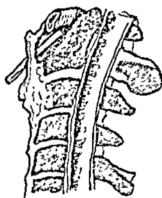
cutaneous branches on the side wall of the thorax or with the anterior cutaneous branches and form an abscess close to the sternum. Below the eleventh dorsal vertebra an anterior abscess is likely to pass downwards under the arcuate ligament and enter the psoas sheath. It infiltrates the whole of this sheath and the muscle tissue itself and perhaps will pass backwards to the body surface through the triangle of Petit. When it reaches the inguinal ligament it usually pauses in its spread and for a time forms a bulge here before resuming its path beneath the ligament into the thigh. A psoas abscess is detected by palpating it at the inner edge of the psoas from the abdomen, by obtaining fluctuation with one finger above and one below Poupart's ligament when the abscess has reached the thigh, and by demonstrating the spasm of the psoas with the patient on his face as

mentioned above, a sign which may be elicited when it has not been possible indubitably to feel a lump in the abdomen. The swelling in the groin made by a psoas abscess gives an impulse on coughing, it is dull on percussion, but it is not reducible into the abdomen and in this respect it differs from a hernia.

(2) LUMBAR REGION: In this region there is not an actual kyphosis. All that occurs is that *the natural lordosis is obliterated*, or in advanced cases forms a slight projection backwards. In profile the appearance



The outline of the normal back compared with the angular kyphosis of mid-dorsal caries and the flattening of the lumbar curve in lumbar disease.

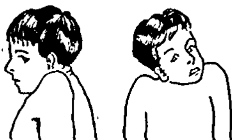


Tuberculous osteitis of the second and third cervical vertebrae with an abscess in front of the axis (retropharyngeal).

is quite characteristic. There is rigidity of the spine, the usual free flexion being quite lost. The abscess *may present* at Petit's triangle or enter the sheath of the psoas and even descend into the pelvis. Pain is felt down the legs. As in dorsal caries, the patient will often be found sitting on a chair partly supporting his weight with his hands.

(3) CERVICAL REGION: *In this part of the spine the disease* is more often found in the atlanto-axial region than in the lower part of the neck. In the former the head is *held rigid* and is usually thrust forwards but is sometimes twisted obliquely to one side. In lower cervical disease the head is thrust forward and appears to be sunken into the shoulders. There is great rigidity, so that either the head cannot be rotated to one side or the neck cannot be flexed laterally. In upper *cervical caries the pain complained of is an occipital headache* and the abscess may track round with the occipital nerves and appear at the back of the head. In other cases the abscess projects anteriorly as a retropharyngeal abscess. Such an abscess will also be detected in the posterior triangle of the neck.

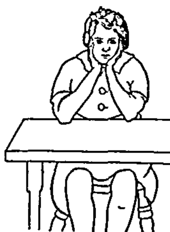
When the disease is in the lower part of the cervical region the pain radiates round to the back of the neck, the front of the neck or down the arm, according to the level of the lesion. The abscess will go round to the back or perhaps be conducted by the brachial plexus into the axilla. In cervical caries the child will often be seen sitting at a table with his elbows on the table, his hands supporting his chin to relieve his spine from the weight of his head; or away from the table with palm supporting the opposite elbow, which in turn supports the weight of the head, the corresponding hand being underneath the chin.



Cervical caries. The hunched shoulders on the left and the torticollis on the right are both characteristic appearances.

Children with Pott's disease are thin and pale and are obviously ailing. They have no appetite and are listless.

When the cord is affected the motor symptoms predominate because the pressure is in front, where the motor tracts are situated. There are weakness of the legs and exaggerated knee-jerks. With disease in the lower dorsal region there may be paralysis of the sphincters; with an upper dorsal lesion retention of urine. Sensory symptoms and trophic changes are only seen in very advanced and severe cases.



Cervical caries. Supporting the weight of the head by the hands: a characteristic position.

In adults Pott's disease may exist for long unsuspected. For in them the bacilli are apt to settle near the anterior or posterior surface of the body of a vertebra, where they set up a periostitis rather than an osteomyelitis. The result is that there is no deformity, and there being no collapse of the vertebrae, no nerves are compressed, so that there is no pain. The first sign indeed may be an abscess. If the disease begins on the back of a vertebra the first sign may actually be due to pressure on the cord.



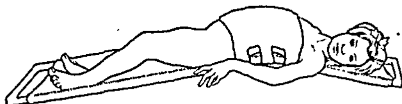
Cervical caries. Supporting chin with hands: a characteristic attitude.

In children it is not usually difficult to diagnose spinal caries, but in adults there may be an absence of pain, rigidity and no kyphosis.

The only evidence is the appearance of an abscess. This again, if it presents on the lateral wall of the thorax, may be taken for one connected with a rib. In fact the diagnosis can be made definitely, solely by the X-ray. In adults with deformity other conditions come into consideration: old age, osteoarthritis, Kummel's disease, osteitis deformans, secondary spinal deposits in malignant disease, acromegaly, and in them often at quite young ages the rare Marie-Strumpel disease. The distinctive features of these several conditions can be learned by reference to the appropriate sections.

Treatment.—In the treatment of the disease it is of the first importance that the patient should be put under the most favourable hygienic conditions and this is best done by sending him to a sanatorium. The principle of treatment is to immobilise the spine as far as possible, a very difficult end to achieve, however it is attempted, and to prevent or correct any deformity which may have appeared or may be reasonably supposed likely. Long ago the older surgeons observed that those patients fared best who developed a pronounced curve. The formation of a gibbus was regarded as of good augury. It was also found that any attempt to undo the kyphosis by manipulation rendered the prognosis worse. The reason for this is not far to seek. As elsewhere, tuberculosis of bone is characterised by a rarefaction, without any new bone formation as the disease subsides. So that it is only by the unaffected vertebral bodies above and below the eroded area being allowed to come into contact and fuse together that there is any prospect of the diseased part becoming rigidly immobilised. This is indeed what actually happens; ankylosis is brought about by the coalescence of outgrowths from the neighbouring healthy bone and the patient is cured. But while the disease is active and the bony bodies undergoing rarefaction, they must not be allowed to collapse. To avoid all pressure on them which increases the gibbosity by mechanical ulceration, the patient must be fixed to and kept on a frame which must be bent at an angle at the site of the disease so that the spine is hyperextended. In this position the weight of the body acting in opposite directions at the two extremities, tends to separate the vertebral bodies; it acts in exactly the same way as traction in the treatment of a tuberculous hip. The frame is usually made of gas-piping and rectangular in shape with canvas stretched across it. The child fixed on this can easily be carried about, and very conveniently the frame may be attached to an undercarriage for transport. This hyperextended position must be maintained for two or more years, until in fact the X-ray shows that a cessation of decalcification has taken place and been succeeded by increased definition in the bones affected, that is when the active disease has been checked and

given way to repair. When this is so the child is turned on his face on the frame, thereby allowing the spine to collapse and ankylosis to



Bradford frame made of gas-piping in the treatment of spinal caries. It fits on to a trolley so that the patient can be wheeled into the open.

occur. It is well after this to carry out still further recumbent treatment, because if the patient is allowed to walk about in this state, although the tuberculous process has been cured, the deformity will increase by the influence of the weight of the body acting too far in front of the vertebral bodies. If, when collapse has satisfactorily occurred, the child again be placed on his back on the frame in the hyperextended position, with pads under his spinal column above and below the gibbus, compensatory curves will develop which will bring the centre of gravity so far backwards that the tendency to increase of the deformity will be abolished. When this has been done the child is usually sent home with a back brace, but a few surgeons advocate bone-grafting the spines together in order to fix the favourable position.



A plaster jacket support for cervical caries.

In adults, when the disease is a periostitis, treatment in hyperextension is not so necessary and simple recumbency is often employed. Treatment in recumbency need not be so long and the patient may the sooner be up, wearing a supporting case, made preferably of celluloid. Bone grafting is very satisfactory in adults.

Plaster of Paris jackets are not very often advisable in the treatment of Pott's disease but they are essential in occipito-axial disease.

During the period of immobilisation, should an abscess be detected, it should be aspirated through intact skin. Sometimes the needle is blocked by solid necrotic masses and aspiration becomes impossible. In this case 20 to 50 c.c. of the following mixture are injected:

Olive oil . . .	50 gm.
Ether . . .	50 gm.
Iodoform . . .	8 gm.
Creosote . . .	2 gm.

The needle is left in for a minute or two after the injection to allow volatilised ether to escape and then withdrawn. This procedure

causes liquefaction. In a few days aspiration will be possible. Tuberculous abscesses often have to be aspirated a number of times. When an abscess has reached so near the surface that the skin is reddening, aspiration should be performed through healthy skin at a little distance away. When an abscess has discharged on the surface and caused a fistula the outlook is made very much worse, as secondary infection will certainly follow and will be very difficult to combat. Injection with the fluid mentioned above or with Beck's paste (Bismuth oxychloride 1, paraffin. molle 1½, liquid paraffin 1½) should be tried first, but in resistant cases the abscess should be freely opened, the wall curetted gently, painted with 5 per cent zinc chloride and the wound sutured in layers. Remarkable cures are sometimes effected in this way.

The outlook for the paraplegic patient is moderately favourable if the hyperextension method is used; it is not made any better by laminectomy.

Spondylitis Deformans

In this disease there are the usual changes seen in osteoarthritis elsewhere. Particularly characteristic in the X-ray is the lipping of the upper and lower borders of the vertebral bodies. Bony ankylosis of the bodies to one another may occur and a similar fusion at the interarticular and costo-vertebral joints. The disease, whilst it occurs typically in late middle life, is met with at any age, even in infancy. There are pain in the back and stiffness. Sometimes there is a kyphosis or a scoliosis. Most commonly it is seen in the lumbar region, when there is a flattening of the lumbar spine. When situated in the dorsal region there is limitation of chest expansion, due to the fusion of the costo-vertebral joints as well as the kyphosis.

The condition is sometimes referred to as Bechterew's disease, in which case it occurs alone, but sometimes it is associated with osteoarthritis of the shoulders and hips, when it is called Marie-Strumpel's disease. The nerve roots in the intervertebral foramina may be pressed upon by bone or inflammatory infiltration so that there are radiating pains and paraesthesias with perhaps muscular wasting. This pain may be felt in the buttocks or down the legs or in the abdomen, when an intra-abdominal affection is simulated. There are exacerbations of pain with intervals of relief but the disease is slowly progressive.

The general treatment is that of osteoarthritis elsewhere. In the acute attacks confinement to bed is required. Heat, especially by diathermy, is useful. Strapping the back by obliquely running imbricating strips of adhesive plaster may give relief. In advanced cases some sort of supporting brace had best be worn.

Spina Bifida

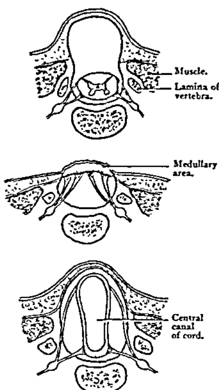
This is a condition resulting from a localised incomplete closing-in of the neural groove.

In the *Myelocele* there remains a cleft in the back actually extending into the spinal canal so that the cord is exposed to the air. Babies with such defects live only a short time.

The *Meningocele* is a swelling which is a protrusion of the membranes alone. Sometimes the roots of the cauda equina form loops within it.

The *Meningomyelocele* has the cord with its nerve roots crossing its cavity to be attached by its extremity to the summit of the swelling in what is called the medullary area.

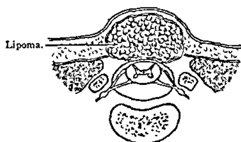
The *Syringomyelocele* has the cord and roots in the sac; the central canal of the cord is enormously distended.

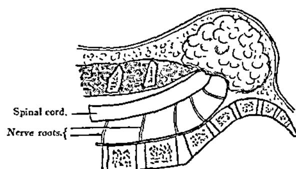


Forms of spina bifida: from above downwards, meningocele, meningomyelocele, syringomyelocele.

In the last three varieties there is a projection on the back which is usually situated in the lumbar region. Spina bifida is ten times as common here as in the cervical region. The skin may be normal over the swelling but usually it is very thin, wrinkled and often ulcerated so that it is covered with granulations. In meningomyeloceles the central reddish area (medullary area) is the spread-out cord. The swellings are flaccid, get tense when the child cries, and are partly reducible. The pressure necessary to effect this may cause convulsions or stupor. The meningoceles are translucent. By transmitted light it may be possible to see the nerve strands in a meningomyelocele. This examination is made very easy and exact if the sac be injected with air and radiographed. Hydrocephalus is apt to accompany the condition or to come on during the first months of life. Defective development of the cord is shown by paralysis of the legs and incontinence of urine, but both these points are difficult to make out in the infant. The absence of the usual extensor plantar response is significant. Club-foot is a frequent accompaniment.

Treatment.—Most of these children die in early infancy, but on the other hand the most unpromising-looking cases sometimes are cured by a surgical operation. It is not advisable to operate in the presence of a hydrocephalus nor when the sac is ulcerating and septic. The prognosis is only really good in the simple meningocele. In the operation the sac is opened to one side at its base, in order to avoid the nerve roots. If it contains no nerve elements the neck is ligated and allowed to drop into the spinal canal. In meningomyeloceles the thin skin over the medullary area is shaved off, the area itself separated from the surrounding sac, and together with the cord and nerve roots, pushed into the canal. In either case a new posterior wall to the spinal canal is made by turning over a flap of muscle and suturing normal skin over this.





Spina bifida occulta with overlying lipoma.

Spina Bifida Occulta

In this condition there is no projection on the back. The defect is confined to the neural arches. Corresponding to the defect there may be a dimpling of the skin, a pigmentation, a lipoma or a growth of hair. Symptoms arise in adolescent or adult life and are attributed to the gradual recession of the cord upwards in the canal. In spina bifida occulta the cord may be attached to the posterior wall of the dural sac in very much the way it is attached to the skin in a meningomyelocele so that the cord gets pulled upon in the process. Trophic ulcers, weakness of the legs and loss of control of the bladder are the symptoms. Club-foot and scoliosis are often present.

The treatment is to separate the cord from its attachment to the sac and repair the gap left, removing the lipoma if it is present. The results are good.

Coccygeal Sinus (Pilonidal Sinus)

This is a small sinus which is found behind the coccyx. It has all the characters of a congenital sinus in that the aperture is a minute pin-point depression. The sinus runs caudally and, as a rule, it does

not go further than the periosteum on the back of the coccyx, but cases have been recorded where it has penetrated into the sacro-coccygeal articulation and even into the vertebral canal. Occasionally branches have been found running along the side of the coccyx round towards the anus.

The origin of these sinuses is not accurately known. The neurogenic hypothesis supposes that they arise from remnants of the neural groove which remain as isolated patches of epiblast between the posterior end of the closed neural canal and the skin of the back where the canal once opened. In support of this hypothesis it is said that neurogenic buds have been discovered histologically growing from a pilonidal sinus. The vestigial hypothesis supposes that the sinus is in reality analogous with the uropygial gland found in some birds, a gland which secretes oil which the bird distributes over its feathers by its beak.

Attention is usually directed to this sinus at about the age of adolescence by an inflammatory reaction occurring in it. An abscess forms and perhaps burrows laterally. If it is opened the condition subsides, only to recur at some later date. On examination the pin-point aperture of a congenital sinus is evident. Sometimes hairs project from the mouth of the sinus, hence the name, pilonidal.

The only treatment is excision. Unless the whole sinus with its branches be removed, recurrence of the trouble is bound to happen. After the sinus has been inflamed the subsequent scarring may make it very difficult to follow the track of the sinus and its branches. The injection of indigo-carmine may be of great assistance. The excision must be sufficiently wide to include all branches. This will usually lay bare the back of the coccyx. The most satisfactory results are obtained if the wound is plugged with vaseline gauze without any sutures being inserted. Convalescence will last for from 4 to 6 weeks.

Sacro-Coccygeal Tumours

A certain number of tumours occur in the region of the coccyx as rareties. They include gliomata in the subcutaneous tissue, which arise from remnants of the neural epithelium; meningoceles from remnants of the terminal meninges; chordomata, which look like myxochondromata, from the remnants of the notochord, and an epithelial tumour which may grow from the coccygeal gland. Another rare cystic tumour seen sometimes in new-born children arises from the neurenteric canal. In this case the tumour is situated in front of the sacrum and coccyx.

Tumours of the Spine

Under this heading, because they ultimately give rise to similar symptoms, are grouped all tumours of whatever origin which come to press upon the spinal cord. Sarcomata of the posterior muscles or growths in the mediastinum may surround the spinal column, grow through the intervertebral foramina and do this. Tumours of the vertebra come under the same group. By far the most common of these are secondary carcinomata, the primary lesion being in the breast, the prostate or the thyroid gland. In hypernephromata the secondary growths also have a predilection for the bones. Multiple myelomata are sometimes found. Sarcomata of the vertebrae are rare and the innocent tumours, osteoma and chondroma seldom seen. Finally the nucleus pulposus (see page 170) may prolapse backwards into the spinal canal, become converted into a nodule of cartilage and behave like a spinal tumour. All the above are extradural tumours. Within the dura we may have intradural but extramedullary, or intramedullary growths.

Intramedullary tumours are quite infrequently seen. They are infiltrating gliomata.

The intradural extramedullary tumours are fibroblastomata either meningeal or perineural, and true neurofibromata, these last perhaps as a part of generalised neurofibromatosis.

Symptoms.—All these tumours eventually give rise to symptoms of invasion or pressure upon the cord. Paralysis partial or complete below the lesion is due to pressure upon the pyramidal tracts, so that it is spastic in type and the deep reflexes are exaggerated, whilst there is an extensor plantar response. Muscles innervated by the part of the cord actually destroyed by the growths are paralysed and flaccid, and the reflexes are abolished. Sensation below the lesion is diminished or lost, and according to the part pressed upon, there may be dissociated sensation (see page 157). There is retention of urine, or, if the bladder centre in the lumbar region is destroyed, dribbling incontinence. These cord symptoms are usually preceded by pain due to pressure upon sensory nerves, and from the character of this pain and the evolution of symptoms it is sometimes possible to guess at the nature of the tumour. Thus when there is a secondary malignant growth in the vertebral column there is very severe pain in the back, lasting for weeks or months, either constant or in attacks. This pain is characteristically made worse by movement. At first this is all there is. When cord symptoms appear from collapse of a vertebra the paraplegia is very rapid in onset and may be complete within 24

hours. Such a train of symptoms should immediately lead to an examination of those organs from which metastasis to the bones is likely to occur, namely, the breast, the prostate, the thyroid and the kidneys.

In intradural extramedullary growths the characteristic symptoms are root pains. These are neuralgic pains referred along a spinal nerve, usually an intercostal nerve because tumours are more common in the dorsal region than anywhere else. They are not accompanied by any physical sign except perhaps some hyperaesthesia. The pain is made worse by coughing or sneezing. After months of this pain, tingling, numbness, loss of power or stiffness in the muscles is noticed.

Later still the cord symptoms appear. There is often some tenderness on percussion of one or more of the spinous processes.

Intramedullary tumours produce cord lesions which are very slow in evolution. There are no root pains.

The level and situation of the tumour can usually be determined by a careful consideration of the symptoms (see page 153). When in doubt an injection of lipiodol (1 to 2 c.c.) into the cisterna magna will be decisive. The patient being upright, the heavy oil will fall down the spinal canal until it comes to the obstruction caused by the tumour, where it stops, and can be photographed. Since lipiodol is not absorbed and sometimes has a slight irritating effect, this examination should be omitted unless it is impossible to arrive at a diagnosis in any other way. The injection of air into the spinal canal will often give as much information as lipiodol injection. Spinal puncture below the tumour will show whether there is a block of the canal or not, for when the cerebrospinal fluid cannot be replaced from above, it changes in character, being mixed with an exudate from the blood plasma. Thus it becomes yellow in colour (xanthochromia), may clot on standing and contains globulin. There is no increase in the cells. These signs constitute Froin's syndrome.

Another test to reveal spinal block is that of Queckenstedt. A lumbar puncture is made and a manometer fixed to the needle. In normal people quite light pressure upon the jugular veins will cause the fluid in the manometer to rise 10 to 30 mm. When the spinal canal is blocked there is no rise.

Treatment.—It is useless to attempt to remove secondary tumours of the vertebrae. It is also seldom possible materially to benefit the intramedullary tumours, so that, except in cases of prolapse of the nucleus pulposus, surgery is almost exclusively restricted to the removal of the intradural extramedullary growths which cause all their symptoms by pressure upon the nerve elements. The operation of laminectomy is performed. In this the spinal muscles are stripped

off the laminae of three or four of the vertebrae in the region of the growth and the laminae removed. Fibroblastomata of the dura or of the sheaths of the nerve roots may be excised or, rarely, an osteoma or chondroma chiselled off. Sometimes it is possible to take away a sarcoma of the dura mater. Neurofibromata, through the substance of which the nerve fibres of the roots run, can only be removed by sacrifice of the nerve roots, and this, when the tumours are multiple, is negatived. Dura which is cut away is soon replaced as happens in the cranium. The operation has not a very high mortality. Very great relief can be confidently expected if the pressure upon the cord has not lasted too long.

CHAPTER XVI

DISEASES OF NERVES

INJURIES

Degeneration.—When a peripheral nerve is divided Wallerian degeneration takes place. Below the level of section there are sensory, motor and sympathetic paralysis. The anaesthesia does not always correspond to the anatomical distribution of the nerve, for there is some overlapping of sensation by neighbouring nerves. The most extensive loss is that to light touch, as with a piece of wool (epicritic sensation). Within this area is a smaller one in which there is no appreciation of pain as tested by a pinprick (protopathic sensation). The sympathetic paralysis is revealed particularly by changes in the skin. It may be red or cyanosed and have a blotchy appearance. It is shiny, dry and loses its hair. There is atrophy of the subcutaneous fat which is especially evident in the case of the fingers, which take on the appearance of talons with their prominent interphalangeal joints and brittle nails curving over the wasted finger pulp. Sometimes there are actual trophic sores; blisters due to unappreciated burns by hot objects may be seen. The joints become stiffened from contraction of their capsular ligaments.

Electrical Tests of Nerves.—When a nerve has been divided there is loss of response of the muscles to faradism, the electrode being placed over the motor point of the muscle, and there is an alteration in the response to galvanism. With an intact nerve the muscle gives a sharp contraction at the make of the current and a stronger sharp contraction at the break. But when the nerve has been divided the contraction is a sluggish one and it may begin at the anode.

Regeneration.—This may occur if the divided nerve ends are sutured together. Such regeneration takes place solely from the central end by axis cylinders growing down the peripheral degenerated nerves towards the periphery. It has been conclusively proved that there is no regeneration in the distal end apart from this. There are certain facts about regeneration which are of importance surgically.

The axis cylinders in the central stump divide into a number of branches so that there are actually far more potential axis cylinders than in the original nerve. But in spite of this regeneration restoration of function is never complete. In the first place, some of the branches have an aborted existence. They form little bulbs at their ends and then stop growing. Others turn backwards into the nerve and are lost for purposes of regeneration, whilst others get into the peripheral stump but land up in wrong sheaths, so that when they reach the periphery they find themselves in contact with the wrong end-organs. Sensory fibres may grow down motor sheaths and *vice versa*. Such fibres die. Then, again, the axis cylinders are able to penetrate only a thin layer of scar tissue between the nerve ends. If the gap is too great the chemiotatic urge to reach the distal end is not sufficiently great to direct them all in their right paths. Many wander out laterally and are lost. The prospect of regeneration is best when the divided nerve ends are accurately apposed and there is a minimum of scar tissue. There should be no tension on the junction, and sutures should be inserted in the sheath of the nerve: not through the thickness of the nerve itself. Fine silk appears to be a better suture material than catgut because it produces less reaction in the tissues.

When an injured nerve is exposed at operation one of several types of lesion may be found. There may be a complete division with a neuroma at the proximal end or a mass of scar tissue joining the two ends. If there is a partial division the divided axis cylinders may form a small neuroma within the sheath of the main nerve. Sometimes there is a pseudo-neuroma which forms a swelling in the course of the nerve. All the fibres of the nerve pass through it without interruption of their continuity. The swelling is due to fibrous tissue lying between the nerve strands. The nerve may be found constricted by a band or pulled upon by adhesions.

In order to get good union and regeneration it is necessary to cut the neuroma off slice by slice until normal-looking fibres are exposed. But this should not be done until it is certain that the two ends will come into apposition. A gap may be bridged by extensive freeing of the nerve. This gives 1 inch more length to a nerve in the arm or forearm and 2 inches in the thigh or leg. Or relaxation may be brought about by splinting the joints in a position of flexion. The flexed position should be maintained for 6 weeks before allowing gradual extension. The ulnar nerve may be transplanted to the front of the internal condyle, and this, combined with flexion of the elbow joint, will gain 2 to 3 inches. Freeing the nerve ends may be assisted by stripping up the branches. Where all these methods fail

to bring the nerve ends into apposition, a two-stage operation may be done. The untrimmed nerves are brought into as near apposition as possible and anchored by strong sutures. In 2 to 3 weeks, stretching of the nerve is begun through the medium of the joints and is carried out as rapidly as pain will allow. As soon as full range is obtained the nerve is explored again, when it may be found that enough stretching has taken place to allow the nerve ends to be brought together when they are trimmed.

Only if all such methods fail should nerve grafting be resorted to. The difficulty here is in finding a suitable graft. An autograft is best; a homograft may be successful but a graft from a different species is always a failure. It is very seldom that a human graft from an amputated limb is available, so a piece of nerve from the patient's own body must be used. There are only a few nerves, such as the external cutaneous nerve of the thigh and the internal cutaneous nerve of the arm, which can be sacrificed for such purposes, and these are not ideally suitable, because they are not of equal cross-section with the nerve ends which have to be bridged. Only a proportion of the axis cylinders can grow along the narrow path. Nevertheless such nerve grafting offers the best prospect of success. The scar formed at the line of suture between the distal end of the transplant and the end of the distal segment of the peripheral nerve may act as an impenetrable barrier to the down-growing axis cylinders. Resection of this scar and resuture may allow the axis cylinders to grow on. In doing nerve sutures it is of no advantage to try and isolate the line of suture by surrounding it with cargile membrane, decalcified bone tube, a section of vein or other material. Scar tissue formation in the neighbourhood is increased by doing this.

In partial lesions where there is infiltration of the nerve with scar tissue, incision of the nerve sheath in several places in a longitudinal direction is sometimes useful. If this fails, then, after waiting a sufficient time to prove that no recovery of function will occur, the pseudo-neuroma should be resected.

It has been pointed out that at the end of a divided nerve there is an increase in the number of axis cylinders brought about by branching. Dogliotti has suggested that advantage should be taken of this fact in partially paralysed nerves. In a child with almost complete paralysis of one leg from anterior poliomyelitis there was considerable recovery of function following division of the sciatic nerve and immediate suture.

In animals it has been shown that if a motor nerve be divided and the cut end implanted into a muscle, new motor end-plates will be formed (neurotisation of muscle). This has not received much

application to human surgery as the conditions calling for it do not often occur, but the fact should be borne in mind.

After suture, *regeneration* is a slow process. It is estimated that the axis cylinders advance a millimetre a day. As to function, protopathic sensation appears first, then epicritic sensibility, and finally there is return of motor power. *When a nerve is regenerating it is* tender to pressure at the advancing end (Tinel's sign). This is a useful phenomenon in judging the progress of the repair. The muscles also become tender to squeezing shortly before there is return of power.

It must be emphasised again that the division of a nerve is a very serious accident, for restoration to function is never perfect. The results in the case of the musculospiral nerve, in which there are few sensory fibres, are much better than in the median or ulnar nerves, which are more mixed in nature. Highly skilled movements are never possible after division of one of the two latter nerves. It is in *division of these nerves that trophic changes in the hands are so* troublesome. Fortunately these bad effects disappear even though motor function remains so imperfect. In the leg the prospect of *restoration of function is fairly good in the sciatic nerve.* The power of regeneration lessens as time elapses after the division of a nerve, but operation should be carried out up to at least two years from the time of the accident.

Injuries and Disease of Individual Nerves

Neuritis is a condition in which there is a demonstrable lesion of the axis cylinders of a nerve. Neuralgia is a condition in which intense pain is felt due to some affection of the nerve terminations or the corresponding sensory ganglion, though these lesions cannot always be satisfactorily demonstrated. Many forms of neuritis are due to toxins circulating in the blood, such as alcohol, lead or arsenic, and do not call for surgery. *Single nerves may be injured by pressure* or poisoned by their severed ends lying in a septic wound. This last is a serious form of neuritis for it may be very intractable, even resection of the nerve above the wound proving ineffective when the condition has been in existence for a considerable time.

Causalgia is a special kind of *traumatic neuritis seen particularly* in war wounds. The median, or the tibial portion of the sciatic, are the nerves most often affected. The pain begins a few days after the wound occurs. [illegible] in type and is subject to paroxysmal exacerbations. [illegible] or years, wearing out the patient. A very slight [illegible] *as a touch, a cold blast of air*, a loud

noise or even an emotional disturbance will set up a spasm of pain. Always the patient avoids moving his limb or contact with anything. Motor paralysis and loss of sensation are not prominent but trophic changes are. Usually the affected part is warmer, the skin dry and scaly, the hair long and coarse. Less frequently the limb is colder than the rest of the body, the skin thin and moist with loss of hair. The fingers are tapered, the nails clawed. In the former variety cold water may relieve the pain: in the latter, warm compresses may do the same. A spotty osteoporosis occurs in those patients with the warmer limbs. Treatment is difficult and not very satisfactory. Freeing the nerve from scar tissue does not relieve the pain. Cutting the median nerve, because it causes anaesthesia and motor paralysis, is not permissible, and even this does not certainly stop the pain. Similarly the injection of alcohol is objectionable and may give relief for only a short time. Sometimes the disease gets well spontaneously. Preganglionic sympathectomy is the only surgical method which will bring about a cure.

The *Olfactory Nerve* is rather frequently injured in fractures of the base of the skull which cross the cribriform plate of the ethmoid, though the damage is often overlooked.

The *Optic Nerve* likewise sometimes is destroyed in fractures of the base of the skull, with total blindness of the eye on the same side.

The *Third*, *Fourth* and *Sixth Nerves* all may be involved in a fracture of the skull, but particularly the sixth as it passes close to the posterior clinoid process.

The Trigeminal Nerve.—This nerve is rarely injured; it most commonly requires surgical treatment because of neuralgia or tic douloureux. This curious condition begins as a severe attack of pain in the area of distribution of the fifth nerve, usually the second division. The pain is excruciating in character and soon radiates from the teeth to the whole side of the face, the lips and tongue. After a time the pain ceases. Throughout the disease there are intervals during which the patient is free from trouble which alternate with the periods of intense pain. During the susceptible periods a paroxysm may be precipitated by the most minute and negligible stimuli, such as a cold draught, a light touch on the face, shaving or washing. The facial muscles on that side of the face are relaxed, giving the patient a vacant expression, and when the attacks are on there are often twitchings of these same muscles. The disease persists with perhaps some lessening of the intensity of the attacks but with no real abatement, so that the victim is driven to get relief from anodyne drugs. Alcoholism or drug addiction are not rare. The pathology of the condition is not known. There are no changes to

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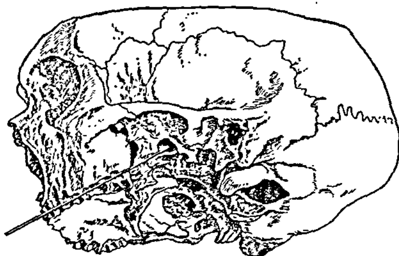
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be *found in the course of the nerve nor in the* Gasserian ganglion. But the disease has a peripheral origin because, in the early stages, the attacks can be stopped by severance of the affected division.

Treatment should always begin with a search for infection in the pulp cavities of the teeth or the accessory sinuses of the nose. If *correction of disease in these situations* fails to bring relief, as it always does in true trigeminal neuralgia, then destruction of the Gasserian ganglion by injection with alcohol should be carried out.





Injection of the Gasserian ganglion. See preceding figure.

If the injection be accurately placed, *relief is permanent.* If, *however,* success be not attained, division of the *sensory* root is indicated. Because injection causes a certain amount of fibrosis in the neighbourhood of the ganglion and so renders the operation rather difficult, some surgeons advise the *operation* in the first instance.

Injection may be done by two routes. In one a needle pierces the cheek opposite the second upper molar *tooth* and is directed towards the external occipital *protuberance* and so reaches the foramen ovale *which it* enters. In the other the needle is entered below the middle of the zygoma above the sigmoid notch of the lower jaw, and is directed upwards and inwards to penetrate the foramen. In either case the ganglion is first injected with novocaine to prove that the needle is in *the right place, and then, very slowly,* about 1 cm. of absolute alcohol is injected. Should the *needle penetrate too far and reach*

the subdural space there is great danger of the patient becoming permanently deaf and getting facial paralysis or a squint.

Division of the sensory root behind the ganglion is usually carried out through an opening in the temporal region above the zygoma. In skilled hands the operation, though one of some delicacy, has a very low mortality. It gives the patient permanent relief.

When the whole of the sensory root has been divided the cornea becomes anaesthetic and liable to ulceration. Extreme care has to be taken in the early days after operation. The upper and lower lids are often sutured together for protection: some surgeons try to preserve the innervation of the cornea by leaving some fibres of the sensory root intact. The same complication is of course liable to follow injection of the Gasserian ganglion with alcohol.

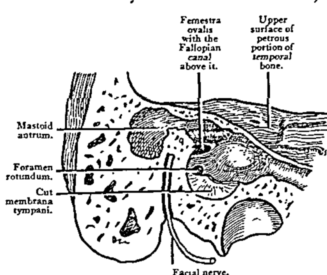
It is not always possible to preserve the motor root. In such case the muscles of mastication on the one side will be paralysed, with the attendant inconvenience. If the motor root must be sacrificed it means that it precludes the performance of the operation on both sides in bilateral cases. For such patients a posterior approach is sometimes suitable. In this, the occipital region of the skull is removed as in operations on the cerebellum. This part of the brain is pushed on one side and access gained to the nerve close to the pons. By this route it is always possible to respect and preserve the motor root. The procedure is contra-indicated in patients over 60 years of age, in plethoric individuals and in people in whom, from radiographs of the skull, there is reason to suspect unusual development of the cerebellar lobes. The method is strongly advised when there is reason to suppose that the pain depends upon a definite organic lesion of the ganglion or is in its neighbourhood. Some small area of anaesthesia or numbness, especially hypoaesthesia of the cornea, are the significant signs pointing to such a lesion, for they do not occur in true trigeminal neuralgia. The formation of an endothelioma is the commonest pathological change in this situation. As time goes on, should the tumour grow inwards, the sixth nerve is first pressed upon, then the third and the fourth, or should it grow backwards the facial and auditory become paralysed. Such endotheliomata may be removed.

The *Facial Nerve* has a long course in the substance of the petrous bone, where it may be damaged in company with the auditory nerve, or affected by the spread of an otitis media or injured during the performance of a mastoid operation. When affected in this part of its course the chorda tympani is also paralysed, causing loss of taste in the anterior two-thirds of the tongue. Operations on the parotid gland, or on cervical lymphatic glands close to the mastoid process,

occasionally are the cause of damage, but it is quite common to find a paralysis of the depressor labii inferioris after an operation in the submaxillary region due to injury to the cervical branch of the nerve. Bell's palsy is due to a neuritis which comes on often with no assignable cause.

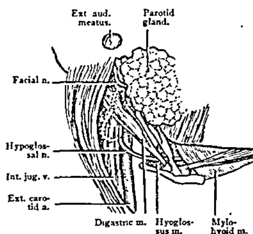
In paralysis of the facial nerve all expression disappears from one side of the face. The eye cannot be closed, and when the patient smiles, the mouth is drawn over to the opposite side. Whistling is impossible and the forehead cannot be wrinkled. Paralysis due to a nerve lesion must be carefully distinguished from facial paralysis due to a cortical affection. In this latter central form of facial paralysis, the loss of function is not so complete, because there is a cortical innervation from both sides. The upper part of the face suffers less than the lower part, and while there is loss of voluntary movement in the facial muscles there is still some power of emotional expression.

Bell's paralysis usually recovers spontaneously but sometimes it is permanent. Facial paralysis associated with middle ear disease also tends to disappear, and so does that due to an injury at a mastoid operation if it has been due simply to bruising of the nerve. The weakness of the angle of the mouth in cervical operations very frequently depends upon the stretching of the branch. In such cases it will clear up. When a facial paralysis has lasted for two months some doubts may be felt as to the future, though recovery may begin to occur several months later than this. But the disfigurement is so great, and the social handicap *is so severe*, that steps should always be taken to remedy the condition in some way if there is reason to think that the condition is permanent; and of course, as in the case of any other nerve, the sooner a suture or grafting is performed the better. When the damage is in the accessible horizontal and descending parts of the Fallopian canal beyond the geniculate ganglion it is possible to expose the nerve and deal with it. Such an operation is recommended in persistent Bell's palsy and when the nerve has been severely damaged



The course of the facial nerve through the temporal bone.

in a mastoid operation. A nerve decompression suffices for Bell's paralysis. When the nerve has been divided the ends are freshened, placed in apposition and kept there by fibrin glue or a suture. Should a piece of scarred nerve have to be resected a graft from the external cutaneous nerve of the thigh is used to unite the ends. When the damage is at an inaccessible point in the nerve a facial hypoglossal anastomosis should be done. In this operation both the facial and the hypoglossal nerves are exposed in the neck and divided in such places that the central end of the twelfth nerve will easily reach the peripheral end of the facial. These two ends are stitched together. Very little disadvantage comes from the paralysis of one side of the tongue and some recovery of function returns to the face muscles. That is, the tone of the muscles comes back so that the face becomes symmetrical again and, if the patient is asked to do so, he can voluntarily close the eye, draw back the corner of the mouth or wrinkle the forehead. But the actual condition of the patient is not so good as one is led to believe by inspection of photographs of patients performing these actions. It is true that they get back voluntary movements, but in emotion the face remains passive and immovable on the one side so that the patient still appears a little odd in conversation. That is why it is so much better to expose the nerve in the petrous bone in suitable cases.



Facio-hypoglossal anastomosis. The facial nerve is divided and turned downwards to meet the severed hypoglossal nerve turned upwards.

Facial Spasm, Facial Tic or Histrionic Spasm.—This is a rare condition in which there are uncontrolled intermittent spasms of the facial muscles, due apparently to a central lesion in the brain. The treatment is by sedative drugs in the usual case but, when the disease is very resistant to treatment, it is right to inject the facial nerve with alcohol temporarily to paralyse it. This is best done by exposing the nerve close behind the angle of the jaw. It is a serious step, as it causes a one-sided facial paralysis. Should the tic recur after injection by alcohol, the only effective treatment is to divide the facial nerve and perform a facio-hypoglossal anastomosis.

The Auditory Nerve.—As has been mentioned above, the auditory nerve is sometimes injured in a fracture of the base of the skull which passes through the petrous portion of the temporal bone. In this

case the facial nerve is usually damaged at the same time. The auditory nerve is subject to neuroma formation (see page 147). Apart from this there are not many lesions of the auditory nerve which require surgery. It has, however, been divided to give relief in Menière's disease; it is approached through the occipital fossa by pushing the cerebellum to one side.

The Glosso-Pharyngeal Nerve.—This nerve is also of very little surgical importance. Very rarely it has been injured by a gun-shot wound. When it is divided there is paralysis of one side of the palate and of the side of the upper part of the pharyngeal wall, so that when the patient says "Ah" the palate is seen to move towards the opposite side of the body. There is also loss of taste over the posterior third of the tongue on the same side. There is another rare disease for which surgery is sometimes necessary, namely glosso-pharyngeal neuralgia or glosso-pharyngeal tic. In general characters this resembles trigeminal neuralgia. There are spasmodic attacks of acute pain beginning in the pharynx in the supratonsillar region and spreading to the side of the tongue and lips. It may be so acute that the only remedy is to divide the glosso-pharyngeal nerve close to the pons. Access to the nerve is gained by making a hole in the occipital region of the skull and turning the cerebellum to one side.

The Vagus Nerve.—The trunk of the vagus nerve is very occasionally injured during surgical operations, especially those for malignant disease in the neck. Sometimes to clear away a growth a section of the nerve is removed intentionally. Division of the vagus nerve on one side has usually very little effect upon the patient, but reflex stoppage of the heart has sometimes occurred and has actually been fatal. Therefore it is wise, if the vagus nerve is to be removed, to anaesthetise it first by injection of novocaine into its substance. Division of the trunk of the nerve is, of course, followed by paralysis of the larynx. The vocal cord on the one side assumes the mid position, the cadaveric position. Phonation is still possible because the intact cord can be brought into close apposition with the paralysed one. The recurrent laryngeal branch of the vagus nerve is sometimes pressed upon by an aneurysm or by a malignant growth in the thyroid gland. A simple goitre does not cause recurrent paralysis. When the nerve is subjected to increasing pressure there first occurs an abductor paralysis of the cord on the one side; if the pressure continues the adductors become affected as well so that there is complete paralysis with the assumption of the cadaveric position. The nerve is sometimes injured during an operation upon the thyroid and, sometimes, a slow compression by fibrous tissue occurs at considerable interval after the operation. If this pressure should happen to be on both

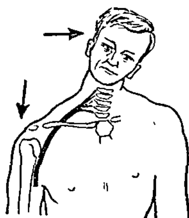
sides then there is bilateral abductor paralysis of the larynx; a very serious condition. Instead of the cords parting during inspiration they tend to come more closely together and intense dyspnoea is the result. At any time a slight stimulus may cause adductor spasm. Actually a tracheotomy may be required to avert death and such patients will have to tolerate a permanent opening in the trachea. If both recurrent laryngeal nerves are divided, or if both vagus trunks are divided, there is complete paralysis of the larynx with aphonia. What is more serious is that the muscles which close the larynx during the swallowing of liquids are also paralysed, so that, while the patient can swallow solids, he is quite unable to take any liquid nourishment without spluttering and coughing. Bilateral division of the vagus is ultimately fatal from septic material entering the lungs and causing pneumonia. The only way to give the patient liquid nourishment is to provide him with a feeding cup to the spout of which is attached a rubber tube which he passes down the throat past the laryngeal opening. Experimentally the phrenic nerve has been anastomosed to the recurrent laryngeal nerve with recovery of function; this is the best nerve to use because, like the recurrent nerve, impulses pass down it at every act of inspiration. A phrenico-laryngeal anastomosis should be considered in complete paralysis of the recurrent laryngeal nerve.

The Spinal Accessory Nerve.—This nerve supplies the sternomastoid and the trapezius muscles, though both these muscles have other nerve supplies. Its course is marked out by a line drawn at right angles to, and from the middle of, another line connecting the mastoid process with the angle of the jaw. It enters the sternomastoid high up, just below the transverse process of the atlas, and emerges from the middle of the posterior margin of the same muscle. It may be divided in the anterior triangle of the neck when there will be paralysis of the sternomastoid and trapezius on the same side but, more often, it is injured in operations upon the glands in the posterior triangle. In this situation the upper part of the trapezius alone is paralysed. The branches from the third and fourth cervical nerves, which also go to this muscle and run a parallel course across the posterior triangle but at a slightly lower level, are liable to injury at the same time; if they are also cut the whole of the trapezius becomes paralysed. Paralysis of the trapezius is rather disabling as it destroys the contour of the neck and patients always complain of pain because the burden of the weight of the upper limb, in which the muscle shares in the normal person, has now to be assumed by other muscles which are not equal to the task. The ability to raise the arm at right angles to the side is interfered with. The point of the shoulder drops,

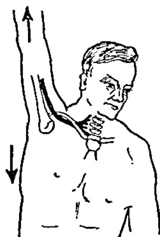
shrugging of the shoulders is impossible and, where an attempt is made to do this, the upper angle of the scapula moves away from the middle line.

The *Hypoglossal Nerve* is very seldom injured. It may be removed in operating upon malignant glands in the submaxillary triangle. If it is cut, one side of the tongue is paralysed so that, on protrusion, the tongue deviates towards the injured side of the body; there soon occurs great wasting of one-half of the tongue. Speech is surprisingly little interfered with.

The Brachial Plexus.—The student should refresh his memory of the anatomy of the brachial plexus before reading this section. The



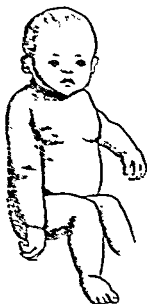
Method by which the upper part of the brachial plexus is torn.



Method by which the lowest root of the brachial plexus is torn.

brachial plexus is liable to injury in two ways; if a man falls so that his shoulder is strongly depressed and his head and neck are pushed to the opposite side, the strain is thrown on the upper part of the plexus and the fifth and sixth roots are torn. This is the upper type of lesion of the brachial plexus (Erb-Duchenne's paralysis). If a man falls from a height and clutches some object to break his fall, the stress is thrown upon the lower roots of the brachial plexus and the eighth cervical and first dorsal roots are torn. This is the lower type of brachial plexus injury (Klumpke's Paralysis). If the injury is very severe all the nerve roots may suffer. The fifth and sixth roots may also be injured during birth. In injuries of the fifth and sixth roots we find paralysis of the abductors and external rotators of the shoulder joint (deltoid, supraspinatus and infraspinatus), and of the flexors of the elbow joint (biceps, brachialis anticus, supinator longus), whilst the adductors and internal rotators of the shoulder joint are weakened (teres major, pectoralis major, latissimus dorsi and subscapularis). The arm is held close to the side rotated

inwards; it cannot be raised at right angles to the body and the elbow cannot be flexed nor the forearm supinated. Sensation is not very seriously interfered with; there is some diminution on the outer side of the arm and forearm. If the injury to the fifth and sixth roots is close to the spine, the serratus magnus and rhomboid muscles may be paralysed. The latissimus dorsi is tested by asking the patient to put his hand on the buttock of the same side and press downwards, which action he is unable to perform. The serratus magnus is tested by asking the patient to push against resistance directly in front of him, when the vertical border of the scapula will be seen to come away from the body in a sharply defined ridge (winging of the scapula). The rhomboids, when paralysed, will allow the lower part of the vertical border of the scapula to recede from the middle line.



Erb's paralysis: 5th and 6th cervical roots.

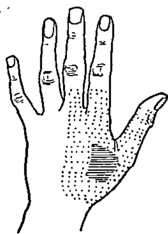
In the lower type of brachial plexus injury the muscles supplied by the eighth cervical and first dorsal nerves are paralysed, namely the flexors of the fingers and the intrinsic muscles of the hand. There is loss of sensation in the ulnar region of the hand and the inner side of the forearm. The pupil may be constricted on the same side because the pupillo-dilator fibres emerge from the cord in the first dorsal root. A lesion of the seventh cervical nerve causes a paralysis of the coraco-brachialis muscle and all the muscles supplied by the musculospiral nerve except the supinator longus. This is only injured in association either with the upper or lower roots of the plexus.

The treatment of brachial plexus injuries is not always simple. The birth paralyses of babies have a great tendency to recovery, as indeed have all injuries of the brachial plexus. As soon as possible a splint should be made for the child which keeps the upper arm abducted at right angles from the side, the forearm at right angles to the upper arm and the hand supinated. This position gives relaxation to the paralysed muscles and so favours recovery, which is, in most cases, complete. In adults, after accidents which cause brachial plexus injuries, the same principles should be put into operation and the course of recovery watched for a few weeks. If there is no sign of return of function in some part of the plexus an operation should be carried out to expose it. Unfortunately, in a number of cases the roots are torn so close to the spinal column that resuture of the

ruptured ends is impossible, and in late cases there is such a mass of fibrous tissue that dissection of the nerves is liable to cause further injury. However, there are a number of reports of operations where the nerve ends have been freed, freshened and united by suture with satisfactory results.

Inner Cord of the Brachial Plexus.—The inner cord of the brachial plexus is sometimes injured in a dislocation of the shoulder joint. The signs of injury to the inner cord are signs of injury of the ulnar nerve together with paralysis of the thenar muscles, supplied by the median, and anaesthesia of the inner side of the forearm. There is also some weakness of the flexors of the fingers. The *Posterior Cord* is occasionally damaged by the same dislocation. This injury gives rise to a musculospiral paralysis, paralysis of the circumflex nerve (deltoid, and teres minor muscles) and paralysis of the subscapular nerves (subscapularis, teres major and latissimus dorsi muscles). The circumflex nerve is rarely ever injured alone.

The Musculospiral Nerve.—Division of the musculospiral nerve causes paralysis of the extensors of the elbow joint, wrist joint, metacarpal-phalangeal joints and all the joints of the thumb, also paralysis of the supinators, excluding the biceps. The anaesthesia which results is surprisingly little as a rule. There may be some present in the dorsum of the thumb and the radial side of the back of the hand but, owing to overlapping of the musculocutaneous nerve, it may be impossible to detect any anaesthesia. The patient suffers from wristdrop; he is quite unable to dorsiflex his wrist and he is quite unable to extend the metacarpo-phalangeal joints. Flexion is weak because the action of the flexor muscles is unopposed. In order to test the supinator longus the patient should be asked to flex the elbow against resistance in the semipronated position, when the muscle will fail to stand out. If the nerve is divided above the branches of the triceps it will be impossible actively to extend the elbow joint. The two phalanges of the thumb cannot be extended but the phalanges of the fingers can, if the first phalanges of these digits be supported.



Sensory loss after division of radial nerve. Lined area: complete anaesthesia except to deep prick which feels like a touch. Dotted area: slight loss of sensation to touch, heat and cold.

The musculospiral nerve is most commonly injured in association with a fracture of the middle of the humerus. It is either pressed upon by the ragged extremity of one of the fragments or by callus. It is very rarely severed in two. In these injuries the triceps, as a

rule, escapes. At first, the treatment of musculospiral paralysis should be splinting of the forearm and hand so that there is extension at the wrist and metacarpo-phalangeal joints and flexion of the joints below. In the case of a fracture of the humerus, should no signs of recovery be evident within a few weeks, the nerve should be exposed at the site of the fracture. Pressure upon it can be relieved by the chiselling away of the projecting bone or callus. The nerve should then be separated from the bone by the interposition of a piece of the triceps muscle. Should it be necessary to resect a piece of the nerve the prognosis will be quite good.



Radial nerve paralysis. Flexion of the wrist and metacarpo-phalangeal joints. The thumb is dragged towards the palm.

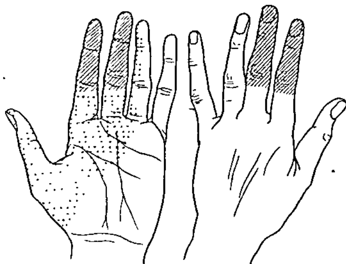
In cases of incurable paralysis of the musculospiral nerve tendons may be transplanted so that dorsiflexion of the wrist becomes possible. The flexor carpi radialis tendon is sutured to the extensor ossis metacarpi pollicis and the extensor brevis pollicis. The palmaris longus is sutured into the extensor secundi internodii pollicis. The flexor carpi ulnaris is threaded through the separate divisions of the extensor communis digitorum. This is one of the few examples in surgery of successful tendon transplantation.

The Median Nerve.—When the median nerve is paralysed the hand becomes ape-like in appearance; it looks larger and broader because the thumb is pulled by the adductors to the side of the index finger, and lies in the same plane. There is a slight ulnar deviation present. In the palm the wasting of the thenar muscles is very evident. If the wrist be flexed it will be found that the only muscles acting are the flexor carpi ulnaris and the flexors of the ring and little fingers. There may be some movement of flexion of the middle finger, but this is only because this finger so often moves with the ring finger owing to the arrangement of the tendons. It is characteristic of median paralysis that the second and third phalanges of the index and middle fingers and the second phalanx of the thumb cannot be flexed. Flexion of the first phalanges on the metacarpals is possible. Opposition of the thumb is also lost. Anaesthesia affects the three and a half digits on the radial side extending up to the wrist joint. However, the extent of anaesthesia is very variable, and particularly this is so in the case of the thumb. On the other hand the second and third phalanges of the index and middle



"Ape" hand of median nerve paralysis. The thumb recedes to the plane of the palm to which it is closely applied.

fingers are anaesthetic front and back without exception. The skin of the hand is red or purple, dry and chapped, but these changes are possibly due to associated vascular lesions. If the nerve is divided just above the wrist then the only muscles paralysed are the three



Sensory loss after division of median nerve. Lined area: complete anaesthesia. Dotted area diminished sensation to pricking, anaesthesia to heat and cold.

thenar muscles supplied by the median nerve (the abductor, the flexor brevis and the opponens pollicis). It is doubtful if complete recovery ever occurs after total division of the median nerve. Anyhow, it is very slow, and particularly so in the case of flexion of the index finger and opposition of the thumb.

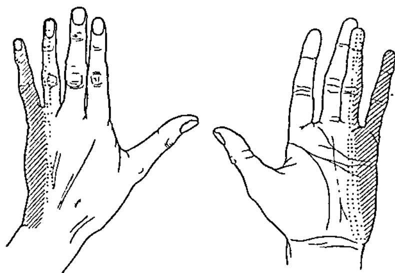
It is in lesions of the median nerve that causalgia is seen more often than in any other nerve injury (see page 192).

The Ulnar Nerve.—When the ulnar nerve is divided at the elbow the hand assumes the characteristic position of "claw hand". The first phalanges of the ring and little fingers are hyperextended, whilst the second and third phalanges are flexed. The little finger stands away from the ring finger and the other fingers are separated from each other, but to a lesser degree. There is great wasting of the first dorsal interosseous muscle and altogether the hand has a skeletal appearance. The flexor carpi ulnaris is paralysed. This is shown by the absence of tension of this tendon just above its insertion into the pisiform bone when the wrist is flexed. The patient is quite incapable of flexing the terminal phalanx of the little finger and he may have great weakness in flexing the similar phalanx of the ring finger. This is due to paralysis of the ulnar side of the flexor profundus digitorum. The hypothenar muscles are paralysed



The hand in an ulnar nerve lesion.

so that the patient cannot flex the metacarpo-phalangeal joint of the little finger. Paralysis of the interosseous muscles can be demonstrated by the inability of the middle finger to carry out lateral movements. It is also impossible for the patient to grasp a piece of paper firmly between two fingers. Anaesthesia affects one and a half fingers on the ulnar side of the hand extending up to the wrist joint. There is some reddening of the skin of the hand, dryness of the skin and brittleness of the nails. At the elbow joint the nerve is liable to be injured in fractures of the internal condyle when the weakness



Sensory loss after division of the ulnar nerve. Lined area: complete anaesthesia. Dotted area: diminished sensation to pricking, anaesthesia to heat and cold.

occurs at the time of the accident, and in fractures of the external condyle of the humerus when the weakness occurs long afterwards owing to stretching of the nerve from a gradual development of a cubitus valgus. If the nerve is divided just above the wrist the forearm muscles are not paralysed and the dorsal cutaneous branch, which has already wound round the ulna, escapes. So that the anaesthesia affects the anterior surface of one and a half fingers and the corresponding part of the palm only. Here, again, recovery from a complete lesion is exceedingly slow and imperfect.

The Sciatic Nerve.—The patient with a divided sciatic nerve has a dangle foot and a high-stepping gait, caused by the effort to prevent the foot from dragging on the ground. The anterior tibial and extensor tendons do not stand out as they do in a normal foot. All the muscles below the knee are paralysed so that the patient can neither stand on his heel nor his toe. If the lesion is sufficiently high the flexors of the knee joint are paralysed. Vasomotor disturbances are very prominent; the foot and the lower third of the leg are very much

swollen. This oedema passes off, to some extent, during the night, but returns before the patient again retires to rest. The skin is of a purple colour; that on the dorsum is satin-like with scales or crusts. On the sole there is hyperkeratosis; the foot is peculiarly dry; there is no sweating except over a strip on the inner side of the foot, which is supplied by the internal saphenous nerve. The temperature is raised perhaps two or three degrees. There is anaesthesia of the whole foot except for this strip on the inner border, and the area of insensibility spreads up, over the external malleolus, to the middle third of the external and posterior surfaces of the leg. Wasting is not visible at first because of the oedema. The knee-jerk is present and rather brisk. The ankle-jerk is absent. Recovery of motor power is fairly good, but complete muscular vigour is very slow in returning.

The External Popliteal Nerve.—When the external popliteal nerve is injured there is drop-foot and exaggerated raising of the knee in walking. The gait is more awkward even than after a complete sciatic paralysis, for the foot appears to get looser from the slackening of the ligaments of the ankle joint. The head of the astragalus and the scaphoid bone project prominently. It is impossible for the patient to dorsiflex the foot at the ankle joint, neither can he extend the proximal phalanges of the toes. Abduction of the foot is lost. No contraction in the peroneal muscles can be felt when the patient attempts to evert the foot. There is a sensory loss down a strip on the outer side of the leg which extends on to the dorsum of the foot to the base of the toes, but does not reach beyond the fifth metatarsal bone on the outer side or the first metatarsal bone on the inner side. There may be some purplish discoloration of the skin, but there is never the oedema seen with sciatic paralysis. Recovery may take place, but is not complete for years.

Cervical Rib Syndrome

There is a form of neuritis which is dependent upon the presence of a cervical rib. Cervical ribs are comparatively common anomalies. They vary in size from a mere tubercle articulating with the transverse process of the seventh cervical vertebra to a complete rib which extends to articulate with the sternum in front. Such complete ribs are not very common. More often the rib extends forwards to articulate with either the extremity of the first rib or the first costal cartilage. Many people possess cervical ribs without there being any symptoms associated with this peculiarity. When symptoms do occur they appear, as a rule, in adult life and are attributed to a dropping of the shoulder girdle so that the lowest trunk of the brachial

plexus comes to lie upon the rib. Hence the malady is likely to appear in people who have to perform work which is rather beyond their muscular powers.

The patient is apt to complain of pain in the areas of distribution of the eighth cervical and first dorsal nerves, that is, pain along the medial side of the forearm, and in the distribution of the ulnar nerve and over the back of the neck where the posterior primary divisions are distributed. Sometimes there is no actual pain but a feeling of tingling or numbness in the limb. There is weakness of the small muscles of the hand and the long flexors of the fingers, so that the patient is apt to drop things.

Much less commonly vascular changes occur. They are a blueness and coldness or pallor of the limb, which sometimes appear in attacks just like Raynaud's disease. The pulse on the affected side may be diminished in volume but it becomes greater when the arm is raised. Sometimes an actual block of the subclavian artery occurs but the collateral circulation maintains the nutrition of the limb. In other cases small vessels of the fingers become blocked and lead to superficial gangrene. It is supposed that these symptoms are due to intermittent compression of the artery between the often present bulbous anterior extremity of the cervical rib and the clavicle. The wall becomes damaged, a mural clot forms from which fragments may become detached and block the peripheral vessels. The subclavian artery may be so damaged that it is locally dilated. It is usually quite easy to palpate the extra rib in the neck where it forms a prominent lump, over which the pulsating subclavian artery may be felt to run. Very similar symptoms are occasionally met with in patients in whom no cervical rib can be demonstrated by the X-rays. In some of these individuals there is a fibrous band occupying a similar position, but in others there is no abnormal anatomical structure. It is supposed that in these patients the symptoms are due to pressure of the first rib on a post-fixed plexus when, owing to muscular weakness, the shoulder has been allowed to droop.

In the treatment of this condition the cervical rib may be removed through an anterior incision in the neck. This will relieve symptoms, but sometimes they recur from regeneration of the rib from the periosteum which has been left behind. A simpler operation, and one which is quite effective, is the division of the tendon of the scalenus anterior muscle. This is quite sufficient to cure the condition. When there are vascular symptoms, however, the scalenus anterior may actually protect the neurovascular bundle from pressure by the clavicle. In this case only rib removal will relieve the symptoms. If [illegible]ure is due to the first rib, this structure had better be removed

in the region where pressure is being caused, that is, from the neck of the rib forwards to the insertion of the scalenus anterior. The results of operation for this condition are very successful, provided it has not been in existence for too long. In one patient, in whom the first rib had been removed again after regeneration from the periosteum, the symptoms returned without there being any demonstrable further bone formation, for the periosteum had been removed also. The symptoms were caused to disappear by division of the scalenus anterior.

Tumours of Nerves

Neurofibromata are tumours of fibrous or myxomatous tissue which grow from the sheaths of nerves or from the endoneurium. In the former case they form oval tumours on the sides of nerves; in the latter the nerve bundles are dispersed through the substance of the tumour. Such single tumours are diagnosed by their being situated on the course of a nerve trunk and by being movable in a direction at right angles to the nerve but not along it. More often than not they do not cause sensory or motor changes. Those on the side of a nerve trunk can be removed easily, but those growing from the endoneurium should be left alone if they are not causing symptoms as their removal would mean a resection of a piece of the nerve. If there are much pain and muscular weakness they should be taken away and the two ends of the nerve sewn together.

Small painful neurofibromata of the cutaneous nerves are quite common. They should be removed. The small branches on which they grow are sacrificed.

Molluscum fibrosum (von Recklinghausen's disease) is a multiple soft neurofibromatosis. There are many small soft tumours of the skin some of which occasionally grow to a great size forming pendulous tumours (pachydermatocele). The fibromatosis may extend to the large trunks and here and there swell them out to form localised tumours. Such tumours may form on the roots of the spinal nerves causing great pain, or on the cranial nerves, particularly the eighth, and being intracranial cause death. The skin is usually pigmented in patches.

Multiple small cutaneous neurofibromata, which are not sensitive, are sometimes confused with multiple subcutaneous lipomata because the latter, whilst developing, are (adiposis dolorosa, Derkum's disease). These small lipomata are seen especially on the forearms of fat women.

When a limb is amputated the axis cylinders in the cut nerve end may branch out into a felt-work which sets up a fibrous tissue reaction and results in a club-shaped swelling which is exquisitely tender to

palpation (amputation neuroma). Sepsis plays a great part in their formation. They should be excised. In the absence of infection they do not recur.

Sarcomata sometimes grow from the sheaths of nerves. They are rapidly growing tumours which cause great pain and quickly lead to paralysis. They need wide removal, so wide that it may be impossible to unite the two cut nerve ends.

Intrathoracic neurofibroma is the commonest tumour of the posterior mediastinum and the posterior part of the superior mediastinum. Growing from an intercostal nerve, it gives rise to the usual nerve pains. A skiagram shows a round opaque shadow. Erosion of the ribs may be caused.

A *ganglioneuroma* growing from the sympathetic cord and containing numerous multipolar ganglion cells is also sometimes found in the posterior mediastinum giving rise to similar symptoms.

Both these tumours should be removed because of the possibility of malignancy supervening.

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CHAPTER XVII

DISEASES OF THE FACE

Injuries

Contusions in the form of black eye are very common. Open wounds bleed very freely but, possibly on account of the great vascularity, it appears difficult for infection to get a hold of the tissues, so that facial wounds heal readily. When operations are necessary on the face the incisions should be made, if possible, in one of the creases, or at any rate parallel with the lines of tension.

Penetrating wounds of the orbit are liable to cause the formation of a large haematoma in that cavity, which will cause proptosis, great swelling of the lids and interference with the movement of the eyeball. The optic nerve may be injured with loss of vision, or one of the motor nerves, with loss of movement of the eye in one or other direction, whilst the weapon may reach the roof of the orbit and go through into the skull, setting up perhaps a meningitis.

Blows on the face may cause a fracture of one of the facial bones: the malar bones, the superior maxilla or the nasal bones.

Fractures of the malar bones are accompanied by swelling and oedema of the cheek, with tenderness at the site of the fracture. It is usually possible to feel an irregularity in the bone. If the deformity is not extreme it should be left, as it is impossible to replace the bony fragments without an open operation, but if the zygoma is driven in so as to interfere with the movements of the lower jaw, there should be no hesitation in making an incision above it and within the hair line through which a lever can be inserted to prise up the bone into its normal position.

Fracture of the nasal bones leads to a disfiguring saddle-back deformity of the nose. This, of course, can only take place when at the same time the bony septum has been broken. It is important that attempts at reposition of the bones into their normal position should be carried out as soon as possible. If days are allowed to elapse they may become fixed in the deformed position and the defect be

subsequently very difficult to remedy. Reposition may sometimes be effected by moulding the nose from without, but great assistance can be obtained by the use of a pair of special forceps, one blade of which is passed up each nostril, to raise the level of the bones from within.

Fracture of the superior maxilla may have as its consequence surgical emphysema, suppuration of the maxillary antrum or alteration in the line of the teeth. Injuries to the nasal wall may interfere with drainage of the accessory sinuses and lead to infection in these cavities.

Inflammatory Affections of the Face

These include boils and carbuncles. Carbuncles are mostly situated on the upper or lower lip. They cause very great swelling and oedema of the lip and cheek with closure of the eyelids. The affected area is red, hard and tender. The affection may be extremely dangerous and threaten life because it spreads so easily to the facial vein, which, if it should thrombose, can lead to pyaemia or cavernous sinus thrombosis by extension up the angular vein into the ophthalmic veins. The patient becomes exceedingly ill with rigors and high temperature. He then develops delirium, becomes unconscious and dies from meningitis.

Every carbuncle of the face or even every boil of the lips, which is more than a very superficial affection, should be regarded in a serious light and the patient kept in bed in order to conserve his powers of resistance. Active surgical treatment is not usually recommended because it is held that incisions may drive the infection into the facial vein and so lead to a fatal complication. This spread of the affection is attributed to the fact that the facial muscles lie in the subcutaneous tissue, and it is said that traction and compression of the veins by the muscles will force the infection along the veins. But when the disease is established the infiltration round it immobilises these muscles, so that this explanation seems scarcely an adequate one. In order to avoid the dreadful complication of cavernous sinus thrombosis, ligation of the angular vein at the side of the nose has been advocated and carried out on numerous occasions. The difficulty in any particular case is to decide when such an operation is necessary. If, owing to the spread of the disease, infected tissue must be cut through, harm may be done in getting access to the vein. It is very difficult to come to a right judgement about the advisability of incising facial carbuncles since no one surgeon is likely to have a sufficiently extensive experience of the disease to possess the necessary data. It is true that most published statistics have been in favour of non-intervention, but, on the other hand, some cases certainly seem to subside rapidly after an

incision to relieve the tension. It is very probable that the danger of spreading the affection by a single surgical incision has been overrated. The outlook has greatly changed for the better with the introduction of penicillin, which should be given in every case.

Tumours of the Face

The common simple tumours are sebaceous cysts, lipomata, angiomata and lymphangiomata. Dermoids also occur.

Dermoid Cysts occur commonly in two places: in the middle line at the root of the nose, or even along the middle of the bridge of the nose, or at the outer margins of the orbit. Dermoids are occasionally seen at the side of the nose in the situation where the maxillary fuse with the lateral nasal processes.

Dermoids are spherical fluctuating tumours not adherent to the skin, which have existed since birth or been noticed soon after birth. They are frequently translucent. If they have suppurated and formed sinuses which refuse to heal, hairs may be found growing out of them. They lie in depressions of the bone. They should be excised.

Sebaceous Cysts and Lipomata resemble those found elsewhere on the surface of the body.

Angiomata may affect the skin only, and then appear as bright-red flat elevations (cutaneous angiomata, capillary angiomata) or be completely subcutaneous and have normal skin over them (subcutaneous angiomata, cavernous angiomata), or be composed of both these elements (mixed angiomata).

Cavernous angiomata are also found in the liver, in bones (usually the lumbar vertebrae), in the intestine and in muscle. Sometimes angiomata appear as solid, elevated purplish-red lesions of the skin which are not compressible because the cavities of many of the vessels have been obliterated by proliferation of the endothelium. This is called the hypertrophic or angioblastic type.

The port-wine naevus (naevus vinosus) is a diffuse telangiectasia of a shallow superficial layer of the derma. The endothelium in these naevi is of the adult type, not embryonic as in ordinary capillary angiomata.

Angiomata of all varieties are of frequent occurrence about the face and are treated as described on page 73.

An extensive angioma of the cheek and lips is sometimes seen which causes great hypertrophy of these structures and presents a very difficult problem in treatment. This enormous tumour extends from the skin to the mucous membrane of the mouth. It is liable to be ulcerated from pressure of the teeth, the result of which may be

a serious haemorrhage. Ligation of the surrounding vessels does very little in checking the growth of these angiomata. The injection of boiling water is the most effective way of dealing with these large tumours, but coagulation with the diathermy needle or sodium morrhuate may also be used.

Rhinophyma is an affection of the nose in which the organ becomes very large and bulbous, red in colour, and pitted with the openings of hypertrophied sebaceous glands. The whole unsightly mass is really due to proliferation of the sebaceous glands. It is actually a mass of sebaceous adenomata.

The unsightly affection can be quite easily remedied by carving away the hypertrophied tissue until the nose assumes its normal shape. There is no need to have any fear for the preservation of skin as the sebaceous tissue left quickly leads to granulations and epithelialisation of the raw area. Bleeding is quite profuse but can be controlled by pressure.

Rodent Ulcer occurs characteristically in the face, the site of election being near the inner canthus of the eye. It may appear elsewhere on the face, ear or neck, but much less commonly. No explanation has ever been given for this predilection for one particular spot.

The rodent ulcer begins as a small papule or a scaliness which persists and then ulcerates. The ulcer is usually covered with a crust, and as it is likely to bleed from time to time, the crust may show evidence of this in the dark-red colour. The margin of the ulcer has a peculiar rolled form and a pearly appearance.

The disease is very slow in its course. The ulcer may remain for years without increasing much in size, but its spread is inevitable, although the older parts of the ulcer may actually heal whilst other parts are increasing in size. If left alone, the sore becomes adherent to the underlying nasal bones, will destroy the eyelids, then the eyeball, and finally penetrate the skull when death will be due to meningitis. The most hideous and extensive deformities can be produced in which a large area of the face is eaten away. There are no metastases in the lymphatic glands which drain the area affected.

The best treatment for rodent ulcer is to excise it, as this is a permanent cure. It is not necessary to cut very wide of the ulcer, as inspection of a microscopic section of a rodent ulcer will demonstrate. Sometimes the removal of an ulcer would lead to a deformity of the eyelids which is not easily remedied. In this case radium is the best treatment. Radium needles are fixed in wax and applied to the ulcer or they may be actually embedded in the underlying tissues (interstitial radiation). Cure by radium is not always permanent, and recurrences are far from uncommon.

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CHAPTER XVIII

DISEASES OF THE MOUTH AND TONGUE

INFLAMMATORY AFFECTIONS

Stomatitis

Catarrhal Stomatitis is likely to occur during the course of many of the specific fevers, particularly if there is sepsis in the mouth, and in people whose health has been undermined by disease. The mucous membrane becomes red and swollen and there is superficial ulceration. The condition heals under treatment with frequent mouth-washes and potassium chlorate internally. A good mouth-wash is the following:

Glycerini acidi carbolici . .	♏ 15
Potassii chloratis . . .	gr. 15
Aquam ad . . .	℥i

Penicillin lozenges should be prescribed.

At the same time all sources of infection in the mouth should be removed. Stomatitis appears in other general diseases such as diabetes in which it is quite characteristic.

Aphthous Stomatitis is seen in badly fed children, suffering from malnutrition, in the form of white patches with a surrounding hyperaemic zone. The general treatment of the patient requires attention here. All that is needed locally is the application of a little glycerinum boracis. *Thrush* also occurs in babies and is due to the *Oidium albicans.* This fungus forms white patches on the mucosa of the tongue and cheeks resembling very much milk curds. General treatment here is also of importance. Sometimes *Herpes* is seen in the mouth. It is part of more general herpes, as a rule, and is associated with severe pain in the tongue which is followed by the formation of the characteristic vesicles. A mouth-wash should be used in the treatment of the resulting small ulcers.

Ulcerative Stomatitis.—This is a much more serious infection in the mouth which occurs in people suffering from severe diseases, such as scurvy, dysentery, typhus or phthisis. It also is seen as the result

Carcinoma of the Face.—Carcinoma grows on the face in the form of an ulcer with raised everted edges. It differs from rodent ulcer in not having the characteristic pearly edge, and also in being of much more rapid evolution and accompanied by enlarged glands in the neck. These carcinomata are particularly common on the lips. If situated on the cheek, according to position, either the upper deep cervical glands or the submaxillary glands may be secondarily involved. If the carcinoma affects the middle two-fourths of the lower lip, the submental gland is the one liable to be enlarged, whereas a carcinoma in the rest of the lower lip or the upper lip delivers metastases to the submaxillary glands.

A carcinoma of the cheek or lips is not usually of a very high grade malignancy. It may exist for a considerable time without spreading very much, and this is particularly true of the carcinoma at the angle of the mouth, which remains for a long time as nothing more than a fissure which becomes encrusted with scabs and persists without healing. Very good results with radium have been obtained with carcinomata of the lips and of the face, and radium treatment is the method of choice. Where it is not available or when recurrence after radium treatment has occurred, then surgical excision is required. Should the whole thickness of the cheek including the mucosa be removed, a difficult and complicated plastic procedure may be needed. Plastic operations on the lip are very much easier.

Simple Ulcers of the Tongue (Dental Ulcer).—These are ulcers which are the result of combined trauma and infection. The trauma is usually that due to a broken carious tooth so that these ulcers are characteristically on the margin of the tongue in the situation where carcinomata are so often found. The mouth is always very septic. The ulcer has a ragged, uneven edge and a sloughing base. There is not usually induration round it; neither are the movements of the tongue restrained. The absence of induration, the presence of the broken tooth and the sepsis are sufficient to render the diagnosis clear, though occasionally it is necessary to perform a biopsy. The removal of carious teeth, the correction of sepsis and prohibition of smoking will quickly lead to healing of the ulcer.

Dyspeptic Tongue (Moeller's Superficial Glossitis).—In this condition areas of the tongue become smooth from the loss of their papillae. At the same time the patient complains of a burning pain which may sometimes be so great that the term "glossodynia" is applied to it. It is called a dyspeptic tongue because there is frequently an associated dyspepsia with anaemia and achlorhydria.

The whole tongue is usually flabby in appearance and has impressions on its side, made by the teeth. There is nearly always oral sepsis. Improvement takes place if the anaemia, dyspepsia and oral sepsis are corrected. The papillae reappear.

Erythema Migrans (Geographical Tongue).—It occurs in weakly children, often those recovering from some serious illness. It begins as a red spot on the dorsum of the tongue, which becomes smooth by the shedding of its papillae. The spot spreads in circles, and when fully developed forms a patch with a circinate margin and yellowish borders, and white patches in the central portions where many of the papillae have re-grown.

There are no special symptoms attached to the disease and no treatment is known which will influence it. It usually disappears with the return of health.

Chronic Glossitis

Chronic Superficial Glossitis (Leucoplakia of the Tongue).—This is a condition of chronic inflammation of the surface of the tongue of which the aetiology is obscure. In 50 per cent of the cases there is a history of syphilitic infection. Nearly all the patients are heavy smokers but instances do occur in which neither of these factors can play a part. In these it is supposed that chronic infection of the mouth is an important contributory cause.

There is first an infiltration of the submucous tissue with round

of poisoning by phosphorus, mercury or lead. It begins on the gums round the teeth as a septic process. It does not seem to occur if the patient has lost his teeth, yet dental caries is not necessary. The ulcerative process spreads to the lips, cheeks and tongue. There is great swelling of the mucous membrane, the formation of ulcers with sloughing bases, fetor of the breath, and, should the process spread backwards, perhaps oedema of the larynx with dyspnoea. A mixture of organisms is usually responsible: staphylococci, streptococci; the fusiform bacillus and spirilla, such as are seen in Vincent's angina, are commonly found. In bad cases the disease may go on to noma (see page 109).

If the disease has not spread to the bones and caused necrosis, and the general condition of the patient improves, the stomatitis frequently heals up comparatively quickly. Carbolic and potassium chlorate mouth-washes, alternating with hydrogen peroxide, are necessary locally. If there is scurvy the error in diet should be corrected. In the case of mercury or lead poisoning potassium iodide is indicated. Systemic penicillin and lozenges should certainly be prescribed.

Acute Glossitis

Sometimes an acute inflammation of the tongue occurs with the mucosa of the general mouth cavity sharing in the affection. Infecting organisms may be the streptococcus or the staphylococcus. The staphylococcus is more likely to give rise to the formation of an abscess in the substance of the tongue.

The symptoms are acute pain in the tongue, followed by very considerable swelling so that swallowing and talking are difficult. The result is that the saliva dribbles out of the mouth and the tongue may become so large that it projects between the teeth. The greatest risk to the patient is the spread of the infection backwards to the glottis, causing oedema and asphyxia.

In the treatment pain can be controlled by morphia or other analgesic drugs, hot mouth-washes should be frequently given, and the surgeon should be prepared to perform a tracheotomy should breathing become embarrassed. Penicillin should be given as in other septic conditions. When there is a collection of pus in the tongue this should be evacuated by an incision on the dorsum. As a rule, it is possible to make the incision through the mucosa in the middle line of the dorsum, in which situation there is little haemorrhage, and for the abscess cavity to be penetrated from this incision with a blunt instrument. The patient's head should be in such a position that he does not inhale the pus which escapes.

indicated, after all sources of irritation have been removed, the patient should be recommended to consult his doctor at regular intervals because, should a fissure or a wart appear, it is essential that they should be excised in order to avoid the onset of cancer.

Chronic Deep Glossitis (Sclerosing Glossitis; Gummatous Infiltration of the Tongue; Chronic Parenchymatous Glossitis).—This condition is due to syphilis. There is a widespread infiltration of connective tissue in the substance of the tongue, so that the organ is much thicker than normal and very often, owing to unequal growth of the connective tissue, irregular in shape and lumpy. It is very frequently associated with leucoplakia. Anti-syphilitic treatment is required.

Syphilis of the Mouth

Primary Chancres.—These are sometimes seen on the tip of the tongue. They are at first small, oval, shallow ulcers, but, if secondarily infected, they may become large ragged lesions. Primary chancre is associated with very much enlargement of the glands beneath the lower jaw. This enlargement is of great diagnostic significance. The lesions are exceedingly infective and may contaminate glasses and cups, and so transmit the disease to other people. Therefore the most energetic anti-syphilitic treatment should be instituted as soon as the nature of the ulcer has been proved by the demonstration of spirochaetes in the discharge.

Primary chancres also occur on the lips in the form of small sores or fissures which are indolent and fail to heal. They are also accompanied by very massive glandular enlargement. They are rare in other parts of the mouth, though they do occur on the tonsil.

In the secondary stage, on the mucous membrane of the cheeks, tongue or palate, superficial ulcers are found, or the so-called mucous patches which are ulcers covered with a whitish glistening exudation like the track of a snail (snail-track ulcers). The ulcers are surrounded by a hyperaemic zone and, when they occur in the mouth, are usually accompanied by similar lesions on the tonsils or pharyngeal wall.

There are other signs of secondary syphilis such as general enlargement of lymphatic glands and the characteristic rashes. These mucous patches swarm with spirochaetes and are as infective as primary chancres, so that here also energetic anti-syphilitic treatment is urgent.

In the tertiary stage gummata are found in the tongue or on the soft palate, or there may be chronic superficial glossitis, or the gummatous infiltration of the tongue already described. Gummata in the tongue have a predilection for the dorsum of the tongue, about its middle line. They form at first hard rounded swellings in the sub-

cells in certain areas of the tongue. It is followed by a loss of the papillae over this area which now has one of two appearances. It is either smooth and red (smooth glazed tongue) or it is covered with a white fur. In the next stage the epithelium ceases to be desquamated so that it becomes much thicker and, at the same time, cornification occurs. The result is that the smooth glazed red patch becomes a white, very slightly raised patch (leucoplakia). These plaques of cornified epithelium are apt to become fissured or sometimes the seat of warty growths. In that case carcinoma may rise from the site of a cleft or the root of a wart. Leucoplakia is therefore regarded as a pre-cancerous condition of the tongue. Indeed it is said that if a man with leucoplakia of the tongue lives long enough, he is certain ultimately to suffer from carcinoma of the tongue.

Leucoplakia does not occur solely on the tongue. It is seen on the inner surface of the cheek and lips, where it has the same significance in the development of carcinoma.

Patients who suffer from leucoplakia complain of burning pain in the tongue. The organ is very sensitive to hot drinks, alcohol, pepper, mustard or highly spiced food of any kind. The mouth has a dry feeling. Leucoplakia is very resistant to treatment. In many cases it can never be induced to disappear.

In the treatment it is important to eradicate all sources of sepsis within the mouth; smoking should be prohibited, as also the drinking of strong alcohol or the taking of highly spiced foods. If there is a positive Wasserman reaction neosalvarsan should be given, but it is frequently disappointing in its results. The patient should use a mouth-wash such as is recommended for stomatitis, whilst at night a little ointment should be rubbed into the tongue. Ordinary unguentum eucalypti is very useful for this purpose and gives great relief. Radium has no effect on the disease. If the patches are small they are best eradicated by operation, when, if the patient takes the precaution of avoiding the sources of irritation mentioned above, he may be cured of his disease and remain free from any recurrence. If the disease is extensive it does not seem justifiable to remove large pieces of tongue because of the interference with speech.

An operation was devised by Butlin in which the mucosa from the whole of the anterior part of the tongue, including all the diseased area, is removed and the tongue turned over on itself in order to cover the raw area left. This gets rid of the disease but causes some interference with speech.

The patches of leucoplakia have also been destroyed by diathermy, using a flat electrode. Quite good results can be obtained by this method if the disease is not too extensive. When operation is contra-

pain or tenderness. A deep gumma has these characteristics before it comes to the surface, but its clinical history is usually much shorter than the tuberculous lesion, which may last for many months. Tuberculomata, about the size of a pea, are also found under the mucosa, on the tip or edges of the tongue. They form irregular indurated nodules and show through the mucosa as yellow patches. They ultimately reach the surface when a fissured and branched ulcer results.

Tuberculosis of the tongue is almost invariably associated with phthisis. Only very rarely is it a primary lesion. Therefore careful examination of the chest in every case of tuberculosis of the tongue is necessary. On the cheek or lips the ulcers have the same characteristic appearance as on the tongue.

The treatment is usually directed mainly towards the predominant lesion which is in the lungs. If there is a single ulcer in the tongue it is a good plan to remove it under local anaesthesia, as thereby the patient may be saved from considerable pain. Where ulcers have formed on the lips and cheek and are extensive, they may sometimes be induced to heal by interstitial radium radiation. Where neither excision nor radiation treatment is possible, suffering can be alleviated by powdering the ulcers with orthoform.

Actinomycosis of the Tongue

Actinomycosis sometimes appears primarily in the tongue, but very rarely. It forms a deep nodule within the substance of the tongue, like a gumma. There are no secondary glands such as are found as a rule in tuberculosis of the tongue and in carcinoma. Ultimately the nodules increase in size, reach the surface and form a sinus from which the characteristic granules can be obtained.

Any dental sepsis should be treated, the lesion, if necessary, scraped and penicillin administered in large doses over a long period.

Nigrities (Black Hairy Tongue)

This is a rare condition in which the filiform papillae at the back of the dorsum of the tongue hypertrophy to form long hair-like structures which become black. The cause of this condition is not known though it is always associated with some sepsis in the mouth. Parasitic fungi are sometimes found. It does not, as a rule, give rise to symptoms and there is no very satisfactory treatment for this disease, though 50 per cent trichloracetic acid applied, after drying the tongue, until the surface turns a whitish grey, will sometimes

stance of the tongue which fairly rapidly increase in size, come to the surface, and ulcerate with the formation of rather characteristic ulcers. These ulcers have steep sides and a yellowish slough on the base which resembles wash-leather. The tongue is free from the surrounding induration which accompanies a carcinoma, so that its movements are not interfered with, but a gumma on the edge of the tongue, especially when it has become secondarily infected with pyogenic organisms from infected teeth, is sometimes difficult to distinguish from a carcinoma. In case of doubt the surest way of coming to a decision is to remove a portion of the edge of the ulcer and have it examined microscopically. But 10 days' energetic treatment with potassium iodide will produce a very rapid change for the better in the appearance of any gummatous ulcer of the tongue, so that there is not much delay in treatment if the therapeutic test be used.

Sometimes multiple small gummata occur round the tip of the tongue.

In the case of the palate the gumma forms a prominence, with shelving borders, which softens in the middle and ulcerates. Underneath the yellow slough on the base of the ulcer there may be necrosis of the palate bone so that a perforation of the palate results.

These tertiary syphilitic affections of the mouth quickly clear up with anti-syphilitic treatment.

Tuberculosis of the Mouth

Tuberculosis of the mouth is seen either on the tongue or on the inner surface of the lips or cheek, particularly near the angle of the mouth. The lesion is nearly always an ulcer. On the tongue it is more common on the anterior part than elsewhere. The ulcer is superficial with a thin shelving irregular edge. It is not indurated. The base is uneven with pale oedematous granulations. The surrounding tissue may show caseous foci and have little yellow spots visible through the mucous membrane.

While it is usually said that tuberculous ulcers are exceedingly painful it is by no means always the case, and the absence of pain is not of importance from the diagnostic point of view. Glands in the neck are usually enlarged. Sometimes a larger ulcer is seen on the edge of the tongue which may simulate a carcinoma, but careful clinical examination, absence of induration, and the general appearance of the ulcer will usually suffice to make a correct diagnosis.

Occasionally tuberculosis will cause the formation of a chronic abscess in the substance of the tongue, the nature of which is exceedingly difficult to determine as it is merely a rounded nodule without

infection. The whole tongue swells up, becoming oedematous, painful, projecting out of the mouth, and perhaps backwards over the larynx causing some embarrassment of respiration. When the inflammation subsides the tongue shrinks in size, because of resulting fibrosis. Sometimes it becomes necessary to perform a tracheotomy for acute dyspnoea.

Lymphangiomata and haemangiomata, if small, are best excised. If they are large they are treated by ignipuncture or the injection of boiling water. Where the whole tongue is large from lymphangiomatous formation, a wedge resection may reduce its size to fit comfortably in the mouth.

Fibroma occurs as a small hard tumour, deep in the tongue or on the surface, where it may have a stalk.

Lipomata are found in the tongue, floor of the mouth, or under the mucosa of the cheek or lips.

Papillomata of the Tongue.—Small warts on the tongue are comparatively common tumours. They are quite innocent except those that arise as the result of leucoplakia, which are malignant.

Mixed Tumours.—Tumours similar to those growing from the salivary glands are sometimes seen on the hard palate, where they have their origin in mucous glands in this situation. They form rounded swellings of low elevation, fixed to the palate, and covered by normal mucous membrane. They are easily removed.

Sarcoma.—In the mouth sarcoma is sometimes seen in the tongue where it forms a mass within its substance or a broad-stalked tumour on the surface. The rapid growth of the tumour is the only really distinctive sign. There are no glands enlarged. Wide excision is indicated.

Carcinoma within the mouth is found occurring on the tongue, palate, floor of the mouth or on the cheek.

Carcinoma of the cheek occurs in the form of a warty growth which may have its origin in a patch of leucoplakia. The growth infiltrates the cheek and may reach the surface and even penetrate it, forming a fistula between the mouth and the exterior. Glands in the neck are enlarged. If the tumour is restricted in size and has not penetrated to the surface, it can be removed by excision or by destruction with the diathermy machine. This has the advantage of controlling the haemorrhage from the smaller vessels. If the whole substance and the thickness of the cheek must be removed, a plastic operation will be required to fill up the defect. This is difficult to do because a lining to the mouth must be provided as well as skin for the surface of the cheek. However, quite wide defects may frequently be closed by drawing them together.

cause the patch to disappear. The application may have to be repeated. It is obvious, however, that all sources of irritation, including smoking, should be avoided. The inflammation subsides spontaneously.

Tumours of the Mouth

Mucous Cysts form as the result of obstruction to the ducts of mucous glands on the inner surface of the lips. They form translucent bluish-looking swellings. They are also found sometimes on the inner surface of the cheek or on the tongue. They can be dissected out but it is sufficient to remove the superficial wall of the cyst for a cure to be brought about.

Dermoid Cysts occur in the substance of the tongue, in the middle line. They form rounded projections, visible in the front part of the tongue, shining through the mucous membrane with a yellowish colour. They also project down into the submental region. They are strictly median in position. This, together with the fact that they have a yellowish and not a bluish appearance, distinguishes them from ranula. When they project predominantly into the mouth they are best removed by incising the mucosa beneath the front part of the tongue and shelling them out, but when the projection is mainly beneath the chin, they should be removed by this route, without entering the buccal cavity.

In connection with the upper part of the thyroglossal tract a tumour sometimes forms in the back part of the tongue, close to the foramen caecum, which has thyroid tissue in its walls. These tumours are spherical in shape, may reach a considerable size, form a visible swelling projecting from the tongue, bluish in colour, and perhaps have thin-walled veins coursing over them. They give rise to some difficulty in swallowing and perhaps some alteration in speech. They may be the cause of severe haemorrhage from the mouth.

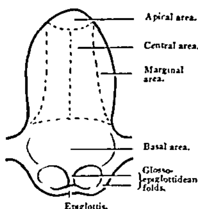
Before one of these lingual thyroids is removed care should be taken to determine whether or not the patient has a thyroid gland in the neck, because they may be the sole representative of thyroid tissue in the body. The existence of a thyroid can only be determined by direct visual inspection through an incision.

Haemangiomata are found in the tongue. They may be of small size or occupy a large area of the tongue.

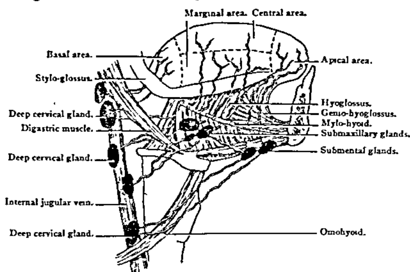
Lymphangiomata are also found and sometimes are the cause of the tongue assuming a large size (macroglossia), so that even the jaws and palate are deformed and the tongue may be thrust out of the mouth.

Haemangiomata are subject to injury from the teeth from which serious haemorrhage may result. Lymphangiomata are subject to

noma may appear as a nodule under the mucosa, which gradually increases in size, reaches the surface and ulcerates. This is the rare submucous form. The usual appearance is a proliferation of the epithelium on the surface of the tongue and the formation of an ulcer there. These malignant ulcers of the tongue are hard on palpation, have a base devoid of granulations and a raised margin. The induration spreads for some distance beyond the margin of the ulcer into the substance of the tongue so that its movements are interfered with. The metastases are found in those glands of the neck which correspond to the site of origin of the tumour. The lymph from the tip of the tongue drains into the submental gland beneath the point of the chin, but some of it goes into the submaxillary lymphatic glands, and some directly along the lymphatics which cross the greater cornu of the hyoid bone, run down the upper border of the anterior belly of the omohyoid muscle, and end in a gland situated at the point where this muscle crosses the



Lymphatic areas of tongue.



The lymphatic drainage of the tongue.

internal jugular vein. The lymph from the base of the tongue flows into a gland situated where the posterior belly of the digastric muscle crosses the internal jugular vein (digastric gland). The lymph from the margin and central portions of the tongue flows partly into the submaxillary glands but also into a chain of glands which lie along the internal jugular vein, between the digastric and

Carcinoma grows from the palate very frequently from the lateral border near the anterior pillar of the fauces, along which it spreads to the lower jaw and the mucous membrane of the mouth beside the posterior part of the tongue. Here it curiously enough may exist for a considerable time without causing pain and without leading to any difficulty in swallowing.

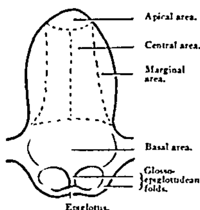
The best treatment in this situation is to excise the growth with a diathermy knife and at the same time to remove any glands in the neck which may be felt to be enlarged. Diathermy is also the treatment of choice for carcinoma of the palate. It is true that radium may be applied to the palate by embedding needles in a dental plate which the patient wears, but there is some danger of causing necrosis of bone. Although diathermy may also cause necrosis of the bone, the sequestrum separates much more easily and the wound will heal in a way which ulcers, as the result of radium, never do.

Carcinoma of the floor of the mouth occurs frequently under the tongue in front, but also at the side. In either case the growth spreads into the tongue and jaw-bone, so that removal necessitates excision of a portion of jaw and a large piece of the tongue with the floor of the mouth. These growths are also likely to cause obstruction to Wharton's duct, thereby causing enlargement and perhaps infection of the submaxillary salivary gland. When they have not already penetrated the jaw, good results can be obtained by the insertion of radium needles or by diathermy, but when the bone is affected it is better to excise the growth with a piece of the lower jaw and a section of the tongue all in one piece. The lower border of the jaw should be left to maintain the shape of the chin. This operation is usually considered a serious one, with a mortality which is due very largely to septic pneumonia following the procedure.

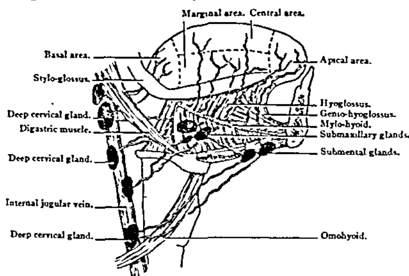
Carcinoma of the Tongue

Carcinoma of the tongue has become a rather uncommon form of carcinoma. It is squamous-celled in type. It grows, as a rule, from the surface epithelium but sometimes from the glands beneath the mucous membrane. The greater number of lingual carcinomata grow on the edge of the tongue but no part of this organ is immune. It is found far more frequently in men than in women and in heavy smokers more than in non-smokers. A very large proportion of men with carcinoma of the tongue have a positive Wassermann reaction. It is particularly apt to grow in tongues affected with superficial glossitis. In such cases it arises either in the walls of a fissure or from a wart. When leucoplakia is not pronounced carci-

noma may appear as a nodule under the mucosa, which gradually increases in size, reaches the surface and ulcerates. This is the rare submucous form. The usual appearance is a proliferation of the epithelium on the surface of the tongue and the formation of an ulcer there. These malignant ulcers of the tongue are hard on palpation, have a base devoid of granulations and a raised margin. The induration spreads for some distance beyond the margin of the ulcer into the substance of the tongue so that its movements are interfered with. The metastases are found in those glands of the neck which correspond to the site of origin of the tumour. The lymph from the tip of the tongue drains into the submental gland beneath the point of the chin, but some of it goes into the submaxillary lymphatic glands, and some directly along the lymphatics which cross the greater cornu of the hyoid bone, run down the upper border of the anterior belly of the omohyoid muscle, and end in a gland situated at the point where this muscle crosses the



Lymphatic areas of tongue.



The lymphatic drainage of the tongue.

internal jugular vein. The lymph from the base of the tongue flows into a gland situated where the posterior belly of the digastric muscle crosses the internal jugular vein (digastric gland). The lymph from the margin and central portions of the tongue flows partly into the submaxillary glands but also into a chain of glands which lie along the internal jugular vein, between the digastric and

omohyoid glands. There is *free communication* between the lymphatics of the two sides at the base of the tongue, at the tip of the tongue and in the central area of the tongue, so that when these areas are affected the glands may be found enlarged on either side of the neck, but when the growth is on the margin of the tongue, only the glands *on the same side of the neck* are likely to be affected.

From the neck the carcinoma *may spread to the glands in the mediastinum.* It is very unusual to find metastases more widespread than this in carcinoma of the tongue. The patient succumbs, as a rule, to septic pneumonia or to a haemorrhage due to the cancerous ulcer invading the lingual or carotid arteries.

Clinically there may be *few symptoms in the beginning.* The ulcer which forms has the malignant characters described above. It renders swallowing painful and difficult and stimulates salivation, so that the patient is greatly troubled by the accumulation of saliva in his mouth from which it sometimes dribbles. Owing to the induration *of the tongue, speech becomes indistinct and the tongue cannot* be protruded freely from the mouth. When an attempt is made to do so, the healthy side will be seen to move much more than that in which the ulcer is situated. Pain may be very severe. The growth invades the lingual nerve so that the pain is referred along the *branches of the fifth nerve. Thus it is felt in the ear and in the* temple as well as in the tongue itself. If there is pyorrhoea or dental sepsis of any kind, the mouth becomes particularly foul and the breath offensive. A secondary haemorrhage from the lingual artery may occur at any time whilst the growth, by spreading backwards, may *invade the larynx and give rise to oedema with death from suffocation.* The glands in the neck are at first hard rounded nodules without any tenderness, but they soon become attached to surrounding structures and fixed. When the growth breaks through the capsule of the gland, as it eventually does, it invades the nerves in the neighbourhood and thus may cause pressure upon the transverse cervical, the descending cervical and the great auricular nerves, pain being felt in the areas of distribution of these branches. The mass invades the sternomastoid muscle, and reaches the skin which breaks down *with the formation of a foul fungating ulcer.* This may eat its way into the carotid vessels and cause fatal haemorrhage. If the patient does not die from this he succumbs to septic pneumonia from inhaling the foul discharge in his mouth, assisted by the fact that his nutrition is bad because he has been unable to swallow sufficient food owing to the pain.

The diagnosis of carcinoma of the tongue is usually simple, but sometimes there is doubt because other ulcers may simulate malignant growth in appearance. This is true of tuberculous ulcers and gum-

mata, particularly when they appear on the side of the tongue. In both cases there may be considerable induration present. Attention should be paid to the special appearances of such lesions as described in the above sections, to the presence or absence of glands, a history of syphilis or signs of phthisis in the chest. Simple septic ulcers of the tongue must also be borne in mind. They quickly disappear when the sepsis of the mouth is corrected, while syphilitic ulcers clear up with the administration of potassium iodide. In every case of doubt a portion of the margin of the ulcer should be removed under local anaesthesia and subjected to microscopical examination.

Treatment.—Carcinoma of the tongue may be removed by a surgical operation, destroyed by the diathermy cautery, or caused to disappear by the application of radium. At the present time radium therapy of the tongue is the most practised. By this means the growth is caused to disappear and very little deformity of the tongue remains, so that the patient loses his growth and neither his speech nor swallowing are interfered with in the slightest. At the same time the procedure is associated with very little risk. Growths at the base of the tongue are said to be more radio-sensitive than those at the tip. Interstitial radiation, effected by surrounding the growth with radium needles, about 1 cm. apart, is the usual method by which this treatment is carried out. The needle should contain 1 mg. of radium bromide and be filtered by 1½ to 2 mm. of platinum. The needles are left in place for 8 days. The tongue swells up, becomes hyperaemic and shows an inflammatory reaction on the surface, but this gradually subsides and in 5 or 6 weeks the growth will have disappeared and the tongue returned to its normal shape. There is a certain risk of making the patient's condition worse if too large a dose of radiation is administered, when the tongue remains for a long time in an enlarged and inflamed condition which is associated with extraordinarily severe pain, so bad that swallowing is almost impossible. The patient gets no sleep and can only be relieved by excision of the organ. Although radium will induce a carcinoma of the tongue to disappear in this miraculous way, so that there is very little sign of its ever having been present, the result is not always permanent. A certain percentage of local recurrences occur. When they do it is frequently found that they are resistant to further radiation and must be destroyed by some other method.

Excision of the Tongue.—Surgical excision of carcinoma of the tongue is associated with a much greater risk than interstitial radiation and, if it is at all extensive, leads to some permanent defect in articulation. On the other hand, if the surgeon can get wide of the growth the likelihood of a local recurrence is very small indeed, less than after radiation.

Carcinomata at the base of the tongue can only be removed by a very severe operation, and sometimes a growth in this situation is not amenable to surgical excision at all. Fortunately these growths are radio-sensitive. For smaller ulcers on the front of the tongue a V-shaped excision is a very satisfactory method of treatment and excision is also good for growths on the lateral margin.

When the growth has spread from the tongue on to the floor of the mouth and gum, radiation is not always suitable because of the bad effect of radium on bone. It appears that the mineral constituents of bone emit secondary radiations which are very harmful to the surrounding tissues. The dose of radiation which is necessary to cause the growth in the soft parts to disappear causes too much damage to the bone. Radium necrosis results which may remain for the rest of the patient's life. In this condition a piece of the bone dies and suppuration occurs round it. Owing to the damage to the marrow in the surrounding bone the sequestrum is not exfoliated in the normal fashion. It remains attached. If it be removed by a surgical operation the radium necrosis is likely to begin again in the raw surface which is left. This subtle change in the bone may occur without there being any actual necrosis present so that, years after the cure of a carcinoma of the tongue, these septic changes may be set going by the extraction of a tooth. It is therefore wise, before carrying out any radiation treatment, to see that all decayed teeth are removed or disinfected, and that pyorrhoea is cleared up. This is just as essential as in operations on the tongue.

The carcinoma we are considering, which spreads from the tongue to the mouth and gums, is best removed by the diathermy cautery. This, itself, may cause some bone necrosis, but the sequestrum will be thrown off in the ordinary way and the wound will heal.

When surgical operations on the tongue are contemplated, a method of anaesthesia should be employed which allows the pharynx to be blocked in order to prevent blood or septic discharge passing down the trachea. Laryngotomy is one method of doing this, but the usual method is to pass a tube through the nose into the glottis. Round the tube gauze strips are packed.

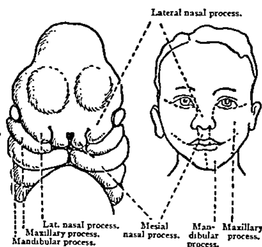
The question of whether the lymphatic drainage area should be dissected out in carcinoma of the tongue is a problem which has not yet been very satisfactorily solved. The difficulty about it is that, even after the most careful dissection of the lymphatic drainage area in the neck, recurrences occur to which the patient succumbs. The ultimate mortality of carcinoma of the tongue, when it is associated with secondary deposits in the glands of the neck, is very high. Many

surgeons believe that the wisest course is to leave the neck alone if no glands are palpable. If there are no deposits in the glands the patient will be cured by the operation in the mouth. If there are deposits in the glands they will become evident if the patient be kept under observation, and it will be quite clear which particular area in the neck requires the greatest attention. When removal of the glands is necessary a very extensive operation is usually recommended, called a block dissection of the neck. In this the internal jugular vein is divided at the level of the omohyoid muscle. It is dissected up with the glands lying along it, the connective tissue of the neck and the sterno-mastoid muscle to the base of the skull. The connective tissue in the submaxillary triangle including the submaxillary salivary gland is also removed. It may be necessary to take away the lower part of the parotid salivary gland. When the growth is in the commonest place, the lateral margin of the tongue, this dissection is only required on one side. It is dangerous to perform a block dissection on both sides of the neck because there is likely to be too much disturbance of the cerebral circulation.

If the growth is on the tip or the central portion of the tongue or at the base, and both sides of the neck need to be dissected, one internal jugular vein should be preserved.

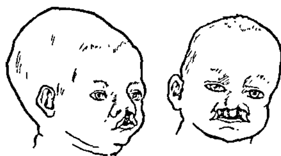
Cleft Palate and Hare Lip

The middle portion of the upper lip is developed from the fused nasal processes which extend downwards from the cranium and form the nose. The lateral part of the upper lip is formed from the maxillary process. These two processes do not always unite. A cleft remains between them. This cleft is situated to one or other side of the middle line of the lip and extends upwards into the nasal aperture. If there is much separation between the two processes the ala of the nose is spread out in a very ugly fashion. The cleft, however, need not be complete; it may be only partial or represented by a mere indentation of the upper lip. There may be a cleft on each side (double hare lip) or on only



The development of the face.

one side (unilateral hare lip). *The front part of the palate and alveolar margin, which bears the incisor teeth, are similarly formed by the nasal process, whilst the hinder part of the palate is developed from the horizontal projections on each side from the maxillary processes which meet together in the middle line and fuse with the nasal septum.*


Cleft lip: unilateral and bilateral.

A hare lip is frequently associated with a cleft of the palate. This is a mid-line cleft of the soft and the greater part of the hard palate, *but in front the slit deviates to* one or both sides round the projecting mesial nasal process. In cleft palate with double hare lip the mesial nasal process, containing the teeth, and the middle part of the lip (prolabium), may project forwards from the under surface of the columella of the nose in a most unsightly fashion. Cleft palate is not always complete. When *it is partial it affects the hinder* part only.


Cleft palate: partial, bilateral and complete unilateral.

Children born with cleft palates are rather weakly infants, perhaps because the primary impulse to development is not as strong as in a properly developed child. They have difficulty in *swallowing and sometimes are unable to suck so that they must be* fed with a spoon. As the child grows it is likely to suffer from inflammatory affections of the nasopharynx, so that there is hypertrophy of the lymphoid tissue in this situation, which is accompanied by a discharge of nasal mucus. Infection may spread along the Eustachian tubes to the middle ear, causing otitis media. A child born with a cleft palate or hare lip should be carefully inspected for other congenital defects such as talipes or spina bifida.

In this country the treatment of hare lip and cleft palate is usually *carried out in two stages. In the first, the lip is repaired.* There are many ways of doing this. One essential is that the cheek should be freely separated from the bone so that the ala of the nose is mobilised in order to allow the formation of a normally shaped anterior naris. Undoubtedly, once the lip is closed the pressure of the orbicularis oris and tension of the buccinator muscles cause the anterior part of the cleft in the palate to close in, thus rendering the subsequent operation slightly easier. Very often, however, closure of the lip is

done in one stage with closure of the anterior part of the cleft palate, if such exists, while the rest of the cleft of the palate is postponed to a later date. It is of first importance to get the child into a sufficiently strong condition to withstand the operation of lip suture (cheiloplasty). This can nearly always be done if the mother takes sufficient care and time in feeding the child with a spoon. When it is 2 or 3 months old the lip can be repaired, though some surgeons think it should be done before 6 weeks. It is better to leave the suture of the palate until a later stage. Some surgeons get their best results if the palate operation be postponed until 3 or 4 years. It is true that, at this stage, the parts are much larger and the operation is considerably easier but, on the other hand, there is a great deal to be said for getting the palate operation done before the child has learned to speak. Thus it is a good plan to operate in the first six months of the second year.

The treatment of the palate presents rather serious problems. When the cleft is very wide there is an actual defect in the size of the part so that there is not really enough material to bridge the gap. Brophy clearly demonstrated that, in certain infants, the alveolar margins of the upper jaw were separated more widely than those of the lower jaw. According to him this is constant in cleft palate babies. Pressure on the inner alveolar margins by the mandible, and pressure of the tongue on the roof of the mouth and the inner aspects of the alveolar margin of the upper jaw, tends to separate the halves of the upper jaw further apart. Thus, in young infants with cleft palates, Brophy declares that it is always possible, by slightly forcing the chin upwards, thus causing pressure of the lower jaw against the segments of the upper jaw, to spring the cleft bones further apart. If the borders *of the fissure are brought into contact by squeezing the* halves of the upper jaw together, then the upper jaw comes back to its normal breadth and into its proper relation to the lower jaw. Plaster casts of the jaws of children with cleft palate undoubtedly, in some cases, bear out this contention, but there appear to be numerous exceptions to the rule. Brophy's method of remedying the defect was to force the two halves of the superior maxilla together by passing wires through the bones above the alveolar margins, right across the cleft and twisting them tightly up till the cleft was closed. This operation has been followed by heavy mortality in this country and has been objected to because it destroys the rudiments of some of the permanent teeth.

The more usual operation is the suture of the two halves of the palate in the middle line. In order to do this the soft tissues must be freed from the under surface of the palate bones, whilst the soft palate

must be given mobility by relaxation incisions over the region of the hamular process. Most surgeons separate the attachment of the soft palate to the hinder edge of the hard palate in order to increase this mobility and some break off the hamular process so as to relax the tensor palati muscle. By such manœuvres the two halves of the palate can be sutured together without tension. The wound sometimes breaks down because of the onset of sepsis and occasionally because the tension on it has not been sufficiently released. Even though the palate is joined together in this way speech does not always become clear, because the antero-posterior length of the palate is lessened and it will not reach the posterior wall of the pharynx in the production of certain consonants and vowels. This closure of the nasopharynx from the rest of the pharynx is extremely important in clear speech production, therefore efforts have been directed to achieve this. One method is to make an incision over the ridge of Passavant which projects horizontally from the back wall of the pharynx forwards just at the point where the soft palate should come in contact with this wall. The mucous membrane on each side of this incision is separated for some distance and the wound sewn up transversely, thus narrowing the nasopharynx. Another method is to pass an encircling suture of silk round the nasopharynx and the palatopharyngeus in this situation, which also accomplishes the same end.

After the operation careful nursing is required in order to prevent the child from crying too much, which places a strain on the palate. Irrigation or spraying of the operation site is not required, but after every feed the child should be given a drink of boiled water in order to cleanse the mouth. Sepsis can perhaps be averted by systemic penicillin.

CHAPTER XIX

DISEASES OF THE JAWS AND TEETH

Inflammations

Inflammation of the jaw usually has its origin in sepsis in the teeth. Bacteria gain access to the pulp cavity of the tooth through caries which opens into it. An acute inflammatory reaction of the pulp occurs (pulpitis) which spreads through the apical canal to the bone round the tooth fang. The inflammatory process here may spread to the surface between the tooth and socket and form an abscess under the gum, close to the neck of the tooth. This is the ordinary gumboil. Or an acute osteitis may be set up and pus reach the surface through the bone, when it will form an abscess under the periosteum. This is called an alveolar abscess. Sometimes when the pus reaches the surface the inflammatory reaction subsides and the tooth preserves its vitality. In other cases necrosis of the pulp and the parodontal membrane occurs with the death of the tooth and perhaps necrosis of the jaw. Sometimes the infection is of a milder character and leads to a chronic rarefying osteitis round the apex of a tooth fang (apical sepsis). This may constitute the focus from which organisms, nearly always streptococci, enter the circulation and pass to other regions of the body, such as the joints or the muscular attachments, where they settle down and cause secondary inflammations.

When there is acute pulpitis the patient suffers from severe throbbing pain because the pus is locked up in a closed space. The affected tooth is very tender on pressure. The gum overlying the jaw becomes red and swollen, and the oedema may spread to the cheek. The submaxillary lymphatic glands are often enlarged. In the acute stage it is important to provide drainage as soon as possible. This is sometimes done by drilling through the jaw to the region of the affected fang. It can also be done by drilling through the decayed area into the pulp cavity. The necrosed pulp



Abscess around the root of a tooth.

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other times the wisdom tooth just shows through the gums but never fully emerges. In this case sepsis is very likely to occur between the overlying soft parts and the crown of the tooth, which, itself, leads to an inflammatory affection of the jaw.

Imperfectly erupted wisdom teeth and those misplaced should be removed. This is sometimes a difficult operation necessitating the outer wall of the alveolar margin being removed by chisel or burr before the tooth can be extracted. Sepsis is sometimes lighted up during this procedure and leads to serious complications.

Osteomyelitis of the Jaws occurs usually as the result of dental sepsis, but sometimes is a primary blood-stream infection. There is usually severe pain, tenderness and swelling of the overlying tissues with, finally, the formation of a sub-periosteal abscess. As a primary measure the abscess should be opened, hot fomentations applied to the face, and mouth-washes frequently used. If necessary the tooth should be extracted. Penicillin is administered.

Necrosis of bone may occur in either the upper or the lower jaw. In the lower jaw the sequestrum is rather slow in separating. When it is loose it should be removed and any overhanging bone chiselled away. Loss of bone is replaced in the case of the mandible, a cartilage bone, but this is not the case with superior maxilla, which is a membrane bone.

Necrosis of the Jaws also occurs in phosphorus poisoning and sometimes is seen in syphilitics whilst under treatment with mercury, particularly if they have considerable dental sepsis.

Radium Necrosis of the Jaw results from exposure of the jaw to the emanations of radium, and is one of the problems of treatment of carcinoma of the tongue and mouth with radium. Apparently the metallic salts in the bone absorb radiations and emit secondary emanations which lower the vitality of the cells within the bone. The dose of radiation necessary to destroy a carcinoma in the soft parts may be too much for the vitality of the bone to be preserved, and necrosis follows. In the treatment of carcinoma of the floor of the mouth and tongue the bone is sometimes protected by lead shields. The damage may not be so great as to lead to immediate death of the bone but it leaves the jaw in such a state that it cannot withstand any subsequent infection or injury, so that, several years after the application of radium, the extraction of a tooth, for example, may be sufficient to start radium necrosis.

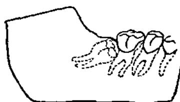
The necrosis is of a particularly intractable nature. Owing to the loss of vitality of the surrounding tissues the dead bone takes a very long time to be exfoliated; even a year or two may be necessary. Should any attempt be made to excise the dead portion of bone,

is removed and the cavity disinfected. If the condition subsides it may be possible to fill the pulp cavity so that the patient can retain the tooth. The most successful fillings of this kind reach just down to the apex of the fang and no further. In the worst cases sufficient drainage can only be obtained by *removal of the tooth*.

Chronic apical sepsis may give rise to very few symptoms and only be discovered by radiography. If there are secondary inflammatory lesions in the body and there is a clear space in the radiogram round the apex of the tooth, then it is usually wise to remove a possible primary focus of infection. The tooth may be extracted; or the cavity drained by drilling through the alveolus to the apex of the root, which is cut off and removed. The tooth can then be preserved. Penicillin is a great aid in bringing such operations to a successful conclusion. It must be remembered, however, that in older people there is frequently some rarefaction of bone around the tooth which *is not due to a septic process*.

Another form of sepsis met with in the teeth is pyorrhoea, or Rigg's disease. This occurs, as a rule, in teeth which are covered with tartar under which organisms lurk. They set up a septic process between the neck of the tooth and the gum. Drainage, being imperfect, the condition persists. The gums are swollen, and on pressure the pus can be caused to exude between them and the tooth itself. In time the gums shrink away from the teeth, which become loose and fall out. They are not, as a rule, carious.

The treatment of pyorrhoea is rather difficult. It can only be effectively carried out by providing free drainage for the discharge. This is done by turning the gum back from the tooth in the form of a flap; the granulation tissue lining the abscess cavity is then scraped away both on the side of the gum and from the roots of the teeth. The gum is replaced, the flaps on the two sides being sutured together between the teeth. They are also usually supported for a few days by a splint made of dental wax. This operation is very successful in eliminating sepsis. Penicillin is again useful.



Unerupted impacted wisdom tooth.

Derangement of Eruption of Wisdom Teeth sometimes leads to an inflammatory affection of the jaw. In these cases a skiagram reveals the fact that the wisdom tooth is placed so obliquely in the jaw that attempts at eruption bring it against the second molar. Sometimes indeed the tooth is placed horizontally in the jaw. Frustrated attempts at growth lead to osteitis with considerable pain and tenderness of the jaw. At

Odontomata

These are tumours of the jaw which grow in connection with the teeth. They are due to some embryological derangement in development.

The following odontomata are described:

1. The Epithelial Odontome.
2. The Follicular Odontome.
3. The Composite Odontome.
4. The Dental Cyst.

The *Epithelial Odontome*, or adamantinoma, or fibrocystic disease of the jaw, is a condition due to the growth of remnants of the enamel organ which have remained embedded in the jaw after the teeth have erupted. The epithelial cells grow out into club-shaped masses which penetrate the bone causing expansion of the bone, which may be very considerable in extent. These epithelial odontomes are more common in the lower than in the upper jaw. In older parts of the tumour the central cells degenerate so that cysts are produced. Hence arose the term fibrocystic disease of the jaw.

The tumours are not malignant in nature and grow very slowly, so that the patient may possess an epithelial odontome for many years, but gradually the bone, albeit it is expanded, will become destroyed.

In the treatment of epithelial odontomes the bone should be exposed by reflecting the soft parts from its surface and the tumour scraped out of the bone, the septa between its different components being removed so that the soft parts may fall into the cavity which remains. If the growth is very extensive this can scarcely be done without a fracture of the jaw, in which case it is sometimes better to excise a whole segment of the jaw and perform a bone-grafting operation subsequently.

The *Follicular Odontome* (dentigerous cyst) arises from the dentinal sac of the foetus, that is, from the condensed connective tissue membrane which surrounds the germ of the tooth. The fully formed follicular odontome is always a cyst in the jaw which contains somewhere in its wall an unerupted imperfectly formed tooth. As it grows it expands the jaw, forming a cyst with thin bony walls which, on pressure, indent like a ping-pong ball. In the upper jaw the cyst pushes in the lining membrane of the antrum and comes to occupy this space. There is always a tooth missing corresponding to the germ lying in the walls of the sac.

In the treatment of this condition the outer bony covering of the cyst must be removed and the cyst membrane peeled out, including the tooth germ. These cysts usually lie in the upper jaw, in which case the incision lies along the outer surface of the superior maxilla, just below the reflection of the mucous membrane of the cheek on to

radium necrosis is extremely likely to be set up in the surrounding tissues, so that the condition spreads. It is a very painful process, and most relief is given to the patient by the use of anodynes and mouth-washes, refraining from active surgery.

Actinomycosis attacks the jaw and so does *Tertiary Syphilis.* In the latter case the diagnosis is usually completed by finding a positive Wassermann reaction.

Leontiasis Ossea (or Diffuse Osteo-Periostitis of the Facial and Cranial Bones). — This curious affection is of unknown origin and is fortunately rare. It consists in the gradual enlargement of the bones of the face and jaws and perhaps of the skull. It nearly always begins in the nasal fossae or sinuses. It spreads to the superior maxillae, which become very large and thickened, showing great bosses on the surface. The antrum of Highmore is filled up with bone. Obstruction occurs to the nasal cavities, to the infundibulum and to the openings of the sinuses, so that epiphora, mouth-breathing and infections of the accessory sinuses are liable to result. If the bone grows up into the orbit, proptosis occurs. The teeth often become septic. The lower jaws are affected as well as the upper jaws and ultimately the disease spreads to the skull bones. The patient becomes hideously deformed, large masses of bone altering the whole contour of his face. Pain is not complained of.

No known treatment influences the course of the disease. It would seem worth while sometimes to remove portions of the bones in order to improve the appearance of the patient, as the disease is very slowly progressive and may last for many years.

An *Epulis* is a tumour of the alveolar margin. There are two forms of epulides. The fibrous epulis grows from the periosteum of the jaw, usually between two adjacent teeth. It forms, as a rule, a pedicled tumour covered with smooth mucosa of a lightish-pink colour. In structure it is a fibroma.

The treatment of the condition is removal. The whole tumour must be taken away or it will recur. Sometimes, in order to remove it effectively, it is necessary to extract the teeth on either side of the stalk and excise a wedge-shaped piece of the alveolar margin. This operation should not, as a rule, be done primarily. An attempt should always be made to preserve the teeth. The more serious operation can be performed should there be a recurrence.

The myeloid epulis is an osteoclastoma growing from the periosteum. It forms a sessile, soft, violet-coloured, bossed tumour growing from the alveolar margin. Like osteoclastomata elsewhere, it is not malignant. It only requires removal and curettage of the bone from which it has arisen.

and the obstruction to nasal breathing, there is frequently very considerable pain because the growth invades the infra-orbital branch of the trigeminal nerve. Haemorrhage from the nose, confined to one side, may be complained of. There may also be epiphora because the lacrimal duct is compressed.

If the growth has not proceeded too far it is possible to remove it. The whole of the upper jaw can be excised. The operation is not one of very great severity and leaves surprisingly little deformity. It is carried out by turning a flap of the cheek outwards, the incision running along the lower border of the orbit to the inner canthus of the eye, down along the junction of the nose and the face, round the ala to the middle line of the lip, which is split in two. The nasal and malar processes of the superior maxilla need to be sawn through and also the hard palate along the middle line. The soft palate is left intact. The bone is then levered off its connection with the vertical part of the palate bone and the pterygoid processes. Haemorrhage from the internal maxillary artery is free but easily controlled. There is no need to make a preliminary ligation of the external carotid artery, but either a laryngotomy should be performed or the trachea intubated in order to prevent blood getting into the lungs. Nowadays, complete removal of the upper jaw is not often undertaken. It is frequently possible to leave the orbital plate, which prevents sagging of the eye. Partial removal of the upper jaw is quite successful. Many cases, however, are now treated with radium. Radium is applied by making a hole in the outer wall of the antrum, or in the floor of the antrum through the hard palate, and implanting needles into the growth. *If there are secondary glands in the neck, already enlarged,* they should be removed.

Malignant disease of the lower jaw forms a mass attached to the mandible. When it is due to secondary invasion of bones by carcinoma, it will always be an ulcerated mass and will be readily diagnosed. If, however, it is a sarcoma, the mucous membrane covering the jaw is likely to be intact and here a differential diagnosis must be made from inflammatory enlargements of the jaw, that is, pyogenic osteomyelitis, actinomycosis, gummatous infiltration and the odontomes. Radiography will be of the greatest help because, in the case of a sarcoma, it will show the destruction of the bone, perhaps with the stippling characteristic of osteogenic sarcoma. Epithelial odontomes give the appearance of a number of separate cavities in the jaw. In syphilis and pyogenic osteomyelitis there will be much new bone formation, whilst in actinomycosis there will very soon appear the characteristic sinuses with the sulphur granules in the discharge.

the gum. A cavity will be left when the cyst has been removed into which the mucous membrane is turned. It is packed and drainage maintained. Many of these cavities gradually become obliterated, but sometimes, if the hole is originally very large, there will be a permanent recess above the alveolar margin requiring syringing by the patient as often as he cares for his teeth. If the cyst is so large that by its removal the antrum itself is opened, it is better to close the wound on the outer side of the jaw and make a new opening for the antrum into the lower meatus of the nose.

A *Composite Odontome* is a small tumour of the jaw which is composed of all the elements which enter into the formation of the teeth, that is, cementum, dentin and enamel. Such odontomes which form small tumours of the jaw are best removed.

A *Dental Cyst* arises in connection with a carious tooth, and it is apparently due to the stimulation of the growth of a remnant of the enamel organ brought about by the irritation of the septic process. Typically, it is a thin-walled cyst above a carious tooth. It has all the characters of the dentigerous cyst and is treated in a similar manner.

Tumours of the Jaws

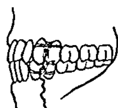
Simple tumours of the jaws are uncommon. They are osteomata or chondromata. Malignant tumours of the jaw are sarcomata and carcinomata.

Carcinoma of the lower jaw begins in the mucous membrane of the mouth and invades the jaw, so that it is a secondary tumour. The same is true of carcinoma of the upper jaw, where disease may begin in the hard palate or on the outer side of the jaw. It may also arise from the lining membrane of the antrum of Highmore.

Sarcoma is found in the upper as well as in the lower jaw. It is frequently an osteogenic sarcoma. Occasionally a melanoma has been met with in the lower jaw.

Clinically, malignant disease of the upper jaw differs in its characters according to its site of origin. If it begins on the outer side of the jaw or the palate it is obvious at an early stage as a solid growth, at first covered by mucous membrane, projecting into the mouth or under the cheek. When it grows within the antrum it causes an expansion of this cavity, then a projection may be seen of the palate downwards into the mouth, or a swelling may appear on the cheek, or if it bulges inwards, the nasal cavity on that side is blocked, or should it press upwards into the orbit, the eye is displaced, whilst movements are interfered with. It may also project backwards into the sphenomaxillary fossa. Besides the deformity which is produced

jaw. Some surgeons have recommended that the teeth on each side of a fracture should be removed, but this is not always necessary as they do not invariably become septic. If there is displacement the teeth should be brought into their proper line and those teeth adjacent to the fracture should be held together by a wire twisted round their necks. The teeth of the lower jaw are now fixed to those of the upper jaw by similar wiring. A barrel bandage is then applied to support the bone from below.



Wiring teeth together for fracture of the mandible.

Another method of treating these fractures is for a dental surgeon to take a cast of the upper and lower teeth in their proper position, from which he makes metal caps which can be fitted to grasp the upper and lower teeth and which themselves can be fixed together by wires. In complicated fractures two screws are driven into the fragments on either side of the break. Their projecting ends are clamped in an apparatus which can be adjusted to maintain the proper apposition of the fragments. Fixation is necessary for three or four weeks. During this time there will be two difficulties—one, feeding the patient; and the other, sepsis in the mouth. The patient will have to live on a fluid diet which he can swallow. It can be introduced along the outer side of the teeth by means of a tube. The teeth become foul from the immobilisation, the inability to cleanse them and the lack of activity in mastication. By the use of mouth-washes and brushing they must be kept as clean as possible; but such hygiene of the mouth is never really effective, so that, as the outcome of a fracture of the jaw, the patient may eventually lose one or more teeth. The administration of penicillin may be a great help in warding off sepsis.

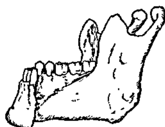
Affections of the Temporo-Maxillary Joint

Dislocation of this joint is not a very infrequent accident. It takes place with the mouth widely open, the condyle slipping forwards over the eminentia articularis. The too strenuous use of a mouth gag may cause a dislocation, particularly under anaesthesia, and even the act of yawning occasionally does so. When the joint has been dislocated once it is liable to be dislocated again, and indeed as the result of very slight violence. Dislocation can occur on both sides at the same time. In unilateral dislocation pain is felt in the region of the joint, there is a depression where the condyle should be situated and a projection in front. The chin is pushed towards the opposite side, the patient is unable to close his mouth, he cannot speak properly,

The best treatment for sarcoma of the mandible is removal of the affected part of the bone. If the whole of the vertical extent of the jaw has to be removed there is likely to be a rather serious deformity. To prevent this a dentist should make an appliance to keep the two fragments of the jaw in their proper relative position until healing of the wound has taken place, and then, perhaps, a bone-grafting operation can be performed.

Fractures of the Jaws

Fractures of the lower jaw are due, as a rule, to blows on the chin. The commonest place for the bone to give way is through the socket of the canine tooth, where the jaw is weakest. The displacement is such that the point of the chin deviates to the fractured side, this being due to the unopposed action of the opposite external pterygoid muscle. The part of the jaw behind the fracture, as a rule, lies higher than the rest of the jaw, so that the teeth are out of alignment. This is due to the unopposed action of the masseter and temporal muscles. Occasionally, from a run-over accident, which presses together the two halves of the jaw, the fracture may occur at the symphysis. The ascending ramus is only rarely fractured. Gunshot injuries may cause fractures of the coronoid process or the condyle, and the neck of the jaw is sometimes broken from indirect violence.



Fracture of mandible: the common site.

Fractures of the lower jaw are always compound if there is much displacement, the thin mucous membrane covering the inner side of the bone being torn. There is frequently very severe and intractable pain in fracture of the lower jaw, which is due to a neuritis of the inferior dental nerve. The pain is the more acute because the nerve is enclosed in a bony cavity in which there is no room for inflammatory exudation.

A patient with a fractured jaw is unable to bite. He keeps his jaw as still as possible so that speech is interfered with and swallowing is difficult. In the treatment of fractures of the lower jaw it is absolutely essential to get the teeth in their proper alignment and ensure that they oppose those of the upper jaw in the proper anatomical fashion. Dentists call this "getting the bite right". If this is not done the patient will never be able to masticate satisfactorily. If there is no displacement, and the alignment of the teeth is correct, then it may be sufficient to apply a barrel bandage so that the teeth of the lower jaw can be kept in apposition with those of the upper

When the ordinary methods of treatment for osteoarthritis have failed to bring relief, operation is sometimes necessary. It consists in removal of the condyle of the jaw.

Cranial Facial Dislocation.—This is, in the main, a separation of the superior maxilla from the skull. The fracture goes through the upper part of the nasal bones, the ascending process of the superior maxilla, the floor of the orbit, the malar bone and through the upper part of the pterygoid plates. The two upper jaws remain together and are loose from the rest of the skull, and can be proved to be loose by holding the head between the temples and moving the jaws from side to side. The chin projects forwards abnormally. This is because the upper jaws fall backwards.

The injury being due to severe violence is often associated with concussion or contusion of the brain. There is bleeding from the nose and pharynx. The parts are so vascular that, if they are replaced, good union occurs. Reduction is correct when the apposition of the teeth is good. The teeth should be wired together and the lower jaw held up by a bandage passing over the vertex of the skull. Union will occur in from 1 to 2 months. The patient is fed in the same manner as in fracture of the lower jaw.

The Orbit

Orbital Cellulitis.—Infection of the cellular tissues of the orbit may occur by a direct wound, by a lymphatic or venous spread from infections of the face or eyelids, by extension from the ethmoid cells or from an abscess of the lachrymal gland. The eye becomes closed from great swelling of the lids. Its range of movement is much lessened. There are proptosis of the eyeball and chemosis of the conjunctiva, great pain and fever. Rarely the optic nerve is involved in this inflammation causing a papillitis and some dimness of vision.

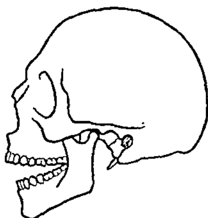
If the condition does not subside with fomentations an incision should be made for drainage through the upper eyelid parallel and close to the orbital margin.

Tumours of the Orbit.—Growths in the orbit cause proptosis of the eye and interference with its movement.

Ivory osteomata grow from the roof of the orbit (see page 504). Gliomas grow from the optic nerve, meningiomas from its sheath or the base of the skull. Mixed tumours, which often become malignant, occur in the lachrymal gland. Lipomata are found and sometimes there develops a mass of chronic inflammatory tissue (pseudo-tumour) which may cause the eye to bulge forward like any other tumour. A rare growth is a sarcoma. This may lead to a pulsating exopthalmos

he cannot eat, and saliva dribbles from his mouth. In bilateral dislocation the mouth is fixed in the open position with the chin in the mid-line, the patient having a rather inane expression.

A dislocation is easily replaced by grasping the lower jaw with the thumb of each hand on the lower molar teeth, depressing the whole jaw and rotating the bone round an axis, passing through the two inferior dental foramina. The jaw comes back with a snap so that the thumbs should be protected by having some cloth wrapped round them, or the surgeon will be bitten by the patient.



Dislocation of mandible.

Internal Derangement of the Joint.—In this condition the interarticular cartilage becomes loose, so that, when the mouth is opened, it slips forwards and becomes wedged between the condyle of the jaw and the eminentia articularis. It is associated with rather severe pain. The locking can usually be undone by lateral manipulation of the jaw. All patients with loose cartilages do not have a typical attack of fixation such as this, but they complain of clicking and pain in the joint on movement.

If the condition is not very pronounced there is no need to do anything, but if the movement of the cartilage is free ultimately osteoarthritis of the joint is likely to occur, which may lead to stiffness and loss of movement. The best treatment in these cases is removal of the fibrocartilage. This must be done through an incision which avoids the branches of the facial nerve.

Acute Arthritis of the temporo-maxillary joint occurs as the result of septic infections. In children this sometimes is due to an extension from otitis media, the tympanic plate being eroded by disease. In gonorrhoea there is also sometimes an acute arthritis.

The treatment of this condition is rest to the joint by a four-tailed bandage, fomentations and evacuation of pus should it form and collect. Penicillin should of course be given. Ankylosis may be the result of an infective arthritis.

The treatment of this complication is excision of the condyle of the bone.

Osteoarthritis is also seen in the temporo-maxillary joint. It is characterised by pain, creaking in the joint on movement and limitation of the extent to which the mouth can be opened. An X-ray will show the disappearance of the cartilage, enlargement of the condyle and excavation of the glenoid fossa.

CHAPTER XX

DISEASES OF THE SALIVARY GLANDS

Injuries of the salivary glands affect the parotid chiefly, as the submaxillary and sublingual glands are protected by the lower jaw. An open wound of the parotid is serious because it may lead to a salivary fistula. Often, however, there is no escape of saliva and such wounds may be sutured and heal by first intention. Occasionally there occurs a subcutaneous collection of saliva and sometimes a fistula.

These fistulae occur not only as the result of an injury, such as a cut by glass in a motor accident, but as the result of an infection of the gland which causes an abscess to rupture on the surface. Occasionally an ulcer of the face may eat into the gland and lead to a fistula. The outside wound may communicate either with the gland or with Stenson's duct. If it communicates with the gland it always connects with one of the larger ducts.

The prominent clinical symptom is discharge of saliva from an aperture in the side of the face. The discharge may be so slight that it only amounts to a drop or two of liquid, or it may be a continuous flow which increases very much during meal times. It may make the patient's life perfectly miserable because he cannot eat in company with his fellows owing to the fact that the saliva pours down his face during the whole of his meal. Sometimes the fluid causes an eczema round the external wound.

In the treatment of injuries to the parotid every effort must be made to avoid a fistula forming, by carefully cleansing the wound and suturing it accurately. At the same time it may be of assistance to probe the duct from the mouth in order to facilitate the discharge of saliva. If Stenson's duct can be seen cut across in the depth of the wound a piece of silkworm gut should be passed into the proximal end and then threaded through the distal part of the duct and brought out of the mouth. Then the tissues should be sutured round the gut which is left to conduct the saliva along its proper channel. The proximal end may be brought out on the cheek and a lead should be placed on it to ensure its remaining in position.

as a cirsoid aneurysm does. Meningoceles occasionally bulge into the orbit from without and so do malignant growths of the antrum.

Besides causing proptosis and, by interfering with eye movements, causing a diplopia, tumours of the orbit may lead to diminution of visual acuity, restriction of the visual field, or hypermetropia from pressure upon the globe. There is not usually any pain. If superficial, a mass may be felt.

Limited access can be got to the orbit by an incision below and parallel with the eyebrow. In Kronlein's operation a piece of the malar bone is reflected outwards in a flap. Very good access is obtained by turning aside a frontal osteoplastic flap hinged on the temporal muscle. The dura is stripped off the roof of the orbit, the brain lifted up and the orbital roof removed.

tion can usually be performed under local anaesthesia. If there is a calculus in the hilum of the submaxillary gland it may be too far back to remove from the mouth, and for this the best treatment is complete removal of the gland itself. A calculus in this situation sometimes leads to a chronic inflammatory condition of the gland which makes it become extremely hard, simulating very strongly, in its characters, a carcinomatous gland; in fact, sometimes the nature of the tumour is only discovered after its removal. In the case of the parotid the stone can be removed from Stenson's duct by incising the inner side of the cheek, but if it lie far back, it can only be reached by an incision through the skin. The stone should be as accurately localised as possible and the external incision, parallel with the branches of the facial nerve, should be made with a knife, only as deep as the parotid fascia. When this has been incised the rest of the dissection, down to the calculus, should be made by some blunt instrument to avoid injury to the facial nerve. Sometimes an incision is made behind the ascending ramus of the jaw and a flap of skin turned forwards in order to avoid a scar on the cheek.

Sialo-Adenitis.—Pyogenic infection of the salivary glands is seen more particularly in the case of the parotid. Infection reaches the gland by passing up Stenson's duct and, therefore, sepsis in the mouth is one cause of septic parotitis. On the other hand, it is quite certain that a haematogenous infection of the gland can take place because from the gland have been obtained typhoid bacilli in the parotitis of enteric fever and gonococci from a parotitis associated with gonorrhoea. Sometimes infection may spread from a neighbouring focus, such as the ear, and invade the parotid tissue.

Septic parotitis is predisposed to by the exhaustion of a long illness and by obstruction of the duct. It is also said that pushing the jaw forwards, with the fingers behind the ascending ramus, in order to prevent the falling back of the tongue during a long anaesthetic, may so traumatise the gland that infection will follow. Post-operative parotitis is certainly predisposed to by sepsis within the mouth. The accessory factor is undoubtedly the stagnation of the saliva within the gland because the patient does not take food during the immediate post-operative period. The most common invading organism is the staphylococcus. A swelling appears which corresponds with the outlines of the parotid gland. It is very tender to touch, and tense, being confined by the dense parotid fascia. There is a high temperature because the infection is under tension, and severe pain is felt in the temple and in the ear. The patient may be extremely ill. As a rule, the condition lasts for about 7 days, when the temperature begins to fall and the whole process subsides within 3 weeks. Bad abscess

Subcutaneous collections of saliva should be treated by aspiration, repeated as often as necessary. When a fistula has become established it may sometimes be closed by cauterisation of the aperture on the cheek. When this fails, the sinus should be excised and the tissues sutured, but if the fistula opens into Stenson's duct, some operative procedure is necessary. One way is to explore the wound, find the two ends of the duct and suture it round a piece of silkworm gut, as above mentioned. If this should fail, by some plastic procedure, a free opening is made into the mouth whilst the external wound is sutured.

When a parotid fistula is quite intractable considerable relief may be given by division of its secretory nerve which comes from the auriculo-temporal. This nerve is found behind the superficial temporal artery and between it and the external meatus of the ear.

Salivary Calculi.—Calculi are sometimes found in the salivary glands, much more frequently in the submaxillary than in the parotid gland. This may be associated with the fact that the secretion of the parotid is serous in nature, whilst that of the submaxillary gland contains a great deal of mucin.

The cause of the calculus formation is usually an infection, but sometimes the mineral salts are deposited round a foreign body which gets into the duct. Salivary calculi occur in two situations; in the main duct, particularly in Wharton's duct, or in the hilum of the gland where they form in one of the smaller ducts. They are composed of calcium phosphate and calcium carbonate, and are usually spindle-shaped.

A salivary calculus may be some time in Wharton's duct without the patient's being aware of it, but if it causes swelling of the mucosa of the duct from irritation, or infection supervenes, then obstruction arises, the result of which may be an attack of severe pain in the floor of the mouth. At the same time the patient notices that during the course of a meal a swelling occurs under the shelter of the mandible and disappears gradually when the meal is finished. The infection may be intense and cause an abscess to form in the gland itself. Along the floor of the mouth, over the course of Wharton's duct, the mucous membrane is red and swollen. The papilla of the duct becomes very prominent, injected and from it pus can be expressed. The calculus can usually be felt in the floor of the mouth. The signs of a calculus in Stenson's duct or the parotid gland are very similar to those which have been described for the submaxillary gland. The calculus can be demonstrated by radiography.

The treatment of calculus in Wharton's duct is removal through an incision made in the mucous membrane overlying it. This opera-

masticates chewing gum. X-ray applications have been successful in reducing the swelling.

Tuberculosis of the Salivary Glands is seen more in the parotid than in the other glands. It is a very rare condition. Sometimes it is primary, but sometimes is due to extension from the overlying parotid lymphatic gland. Should softening occur the best treatment is to make a small incision, scrape out the granulations, and suture the wound.

Syphilis also very rarely gives rise to a chronic parotitis, which may, however, begin rather acutely and quickly subsides with anti-syphilitic treatment.

Actinomycosis is equally rare and is usually not diagnosed until the characteristic sinuses form with their discharge containing sulphur granules.

Mickulicz Disease.—This disease is a rather rare affection of the salivary glands and affects particularly the lymphoid tissue which is always present between the acini. It is to be regarded more as a disease of lymphoid tissue than a disease of the salivary glands. The true glandular tissue in Mickulicz disease gradually atrophies from pressure.

It is a chronic disease. It affects both parotid glands, both sub-maxillary glands and both lachrymal glands, so that the patient has a very characteristic appearance; bulging on each cheek, under each side of the lower jaw and above each eyeball. Occasionally the spleen is enlarged. The disease does not spread outside the capsule of the several glands. There is no pain but there is some difficulty in mastication and swallowing, for the mouth becomes dry owing to the atrophy of the glandular tissue, and the teeth tend to become loose and fall out. Owing to the drying-up of the tears there is conjunctival irritation. There have been a few cases in which the lymphatic glands have been enlarged and there have been pseudo-leukaemic changes in the blood.

A condition which simulates Mickulicz disease is sometimes seen in which both parotids and the lachrymal glands are enlarged, and in which there is an accompanying iridocyclitis. In this case all three lesions are due to the tubercle bacillus.

There is no treatment for Mickulicz disease other than X-radiation, from which encouraging results have been reported.

Tumours of the Salivary Glands

Cysts, due to obstruction of ducts, are occasionally seen both in the parotid and the submaxillary glands, but the commonest cyst is a

formation may occur. It is extremely difficult to detect fluctuation in the parotid because of the dense overlying fascia, so it is not uncommon for an abscess to be unsuspected until it breaks through either into the external auditory meatus, or passes through the aperture in the deep wall of the parotid fascia and escapes into the parapharyngeal connective tissue and advances down the neck along the great vessels. Here it may cause jugular thrombosis or even lead to secondary haemorrhage from the carotid artery. Paralysis of the facial nerve, which runs through the gland, is very unusual. The patient is unable to open his mouth.

Infection of the submaxillary gland causes a swelling under the horizontal ramus of the jaw and also in the floor of the mouth. The overlying mucosa is swollen and injected. The infection may break through under the floor of the mouth causing a Ludwig's angina.

Treatment.—After operations, particularly abdominal operations, it is very important to guard against parotitis as far as possible by care of the hygiene of the mouth. This is done by the frequent use of mouth-washes and the cleaning of the teeth by small wads of cotton-wool dipped in some antiseptic. Orange or lemon juice promote secretion and prevent stagnation.

Septic parotitis must always be regarded as a serious complication. Sometimes the infection spreads extensively and leads either to pyaemia or septicaemia, and death of the patient. When pus is suspected it should be let out by an incision over the most tender spot in the gland. The knife should not penetrate deeper than the parotid fascia, the gland itself being penetrated by some blunt instrument to avoid injury to the facial nerve. Both before and after suppuration occurs hot fomentations are used externally and penicillin administered systemically. In the case of the submaxillary gland, should Ludwig's angina occur, the patient should be treated as indicated on page 276.

Chronic Sialo-Adenitis.—This is a condition of chronic inflammation of the salivary glands. It may affect either the parotid or the submaxillary gland. It causes some enlargement of the whole gland but there is very little tenderness. As the mucosa of the duct is very often swollen, thereby causing obstruction, it is frequently noticed that the gland swells during a meal to subside afterwards. In every case when such symptoms occur an X-ray should be taken to reveal, if present, a calculus. The possibility of the condition being due to tuberculosis, syphilis or actinomycosis should also be borne in mind.

In the case of the submaxillary gland the best treatment is excision of the whole gland. This is impossible in the case of the parotid, in which case warm applications externally and potassium iodide may be of help, whilst the gland may be induced to drain if the patient

The treatment of these tumours is removal. In the case of the parotid the superficial incision should run parallel with the branches of the facial nerve and reach down to and through the parotid fascia. The dissection will be greatly facilitated if the region is infiltrated with adrenalin in order to minimise the haemorrhage and make it possible to see the branches of the facial nerve. As a rule, the nerve lies deep to the tumour but often in very close association with the capsule. The tumour must be removed intact within its capsule or local recurrence is very likely to take place. Great care must be taken in the dissection because of possible injury to the nerve, and it must be remembered that occasionally some of the nerve branches lie superficial to the growth. Now and then two separate tumours are found in the gland. Recurrence does not take place if the tumours are removed within their capsule, but they are so friable that accidental rupture fairly frequently happens. Implantation of tumour cells may occur and lead to the recurrence. It is not necessary to radiate the gland if the tumour has been properly removed. If there is a tumour of any considerable size in the submaxillary gland, it is better to remove the whole gland.

Carcinoma of the Parotid.—This is usually scirrhous in nature. It forms a hard tumour of rapid growth within the parotid. In the early stages it causes paralysis of the facial nerve and later gives rise to severe pain in the region of the auriculo-temporal nerve, that is, in the temple and in the ear.

Occasionally the whole parotid gland is removed but this is a very disfiguring and mutilating operation and may not cure the patient because it is difficult to dissect widely round the growth. As a rule, the only treatment which is justifiable is that by radium.

ranula, which appears to be due to obstruction of one of the ducts of the sublingual gland. The result is the formation of a thin-walled cyst beneath the mucous membrane to one side of the middle line, behind the symphysis menti, beneath the tongue. It is bluish in colour and was given its name because of its supposed resemblance to the belly of the frog. It is easily distinguishable from a dermoid cyst in this situation because the latter is yellow in colour and median in position, whereas the ranula is blue and situated to one side.

The treatment is simple. Small ranulae can be excised whole, but large ranulae are well treated by removing a large portion of the superficial wall, avoiding the ranine vein and Wharton's duct which are seen coursing over its surface, and then suturing the edge of the remains of the cyst to the mucous membrane of the mouth.

A *Lipoma* is sometimes seen in the substance of the parotid gland, but a more common tumour in this situation is an *Angioma.*

If necessary, a lipoma can be removed but an angioma must be treated by cautery puncture or the injection of boiling water.

Mixed Tumours.—These tumours derive their name from the fact that in section they appear to be composed of several tissues, endotheliomatous, myxomatous, chondromatous. Careful investigation, however, has proved them to be really epithelial tumours, in fact, adenomata, and that the several appearances are due to degenerative changes.

Mixed tumours are found more often in the parotid than in the submaxillary gland. They are spherical in shape as a rule, and are



Mixed tumour of parotid gland.



Mixed tumour of submaxillary gland.

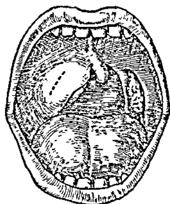
very mobile. They grow extremely slowly so that they may last for 20 or 30 years, by which time, however, they have reached a very large size. There are no symptoms associated with these tumours. They should always be removed because sometimes malignant change occurs within them. They become carcinomatous.

(enucleation). This can be done either by dissection with scissors and forceps or by a special manœuvre with the guillotine. Bleeding may be controlled by the guillotine which has a special blunt blade, or by seizing the spurting vessel, usually in the lower part of the anterior pillar of the fauces, and ligating it. Haemorrhage may be free at first but usually quickly ceases. When the tonsils have been removed the adenoids are scraped off the nasopharyngeal wall by means of an instrument called an adenotome. The operation must be done with care so that no injury to the Eustachian cushion or the soft palate takes place. The general health of a child quickly improves when obstruction to the nasopharynx has been removed.

Catarrhal Tonsillitis and *Follicular Tonsillitis* are treated medically by sprays, inhalations and penicillin and will not be further mentioned here, but if the infection spreads into the glands of the neck, an abscess in this situation may need to be evacuated.

Ulcerative Tonsillitis (Gangrenous Pharyngitis) is usually part of a general ulcerative stomatitis. It is a very severe infection, may spread widely, infect the wall of the pharynx, and actually cause death from secondary haemorrhage of the internal carotid artery. It may be fatal from septic absorption alone.

Vincent's Angina is a pharyngitis in which ulcers form on the pharynx, covered with a grey exudation which is removed with some difficulty from the underlying bleeding surface. The patient is generally ill, but only moderately so. His temperature is raised but he does not show the toxaemia associated with diphtheria. In the membrane are found the characteristic spirillae and fusiform bacilli. Similar ulcers are also met with on the inner surface of the cheek. The organisms responsible are sensitive to penicillin.



Quinsy. Line of incision for evacuation is marked.

Peritonsillar Abscess (or Quinsy).—This is an infection within the fossa of the tonsil but outside the lymphoid tissue, itself. It forms a large tender swelling which pushes the tonsil downwards and bulges the soft palate. There are a high temperature, acute pain and swelling, and pain on talking. The glands in the neck are usually enlarged. The abscess should be opened by an incision which is made through the soft palate and parallel with its posterior margin, extending from the junction of the anterior pillar of the fauces inwards for about 2 cm. The palate must be cut right through and the capsule of the tonsil opened. Immediate

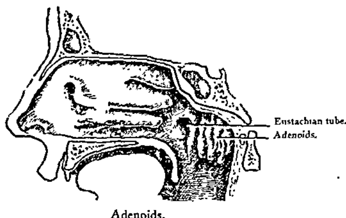
CHAPTER XXI

DISEASES OF THE PHARYNX

Infective Diseases

Pharyngitis is associated with hypertrophy of the nasopharyngeal tonsil or adenoids, and with infection of the tonsils.

Chronic pharyngitis due to these causes is accompanied by a mucous discharge from the nose and mouth by coughing, mouth-breathing, dulness and lethargy. The adenoids form large masses attached to



Adenoids.

the roof of the nasopharynx which grow down and obstruct the posterior nares. The lymphoid follicles become infected and, owing to lack of proper drainage, they remain chronically diseased. The tonsils are usually affected in the same way. They form large masses projecting into the pharynx and from their crypts can often be expressed a purulent discharge. The imperfect aeration of the blood, associated with enlarged tonsils and adenoids, interferes with the proper growth of the child and leads to general ill-health and deficient resistance against disease. The Eustachian tubes may be obstructed and along them infection may reach the middle ear. The general poor health is added to by absorption of toxins from the permanent foci of infection in the diseased lymphatic tissue. Therefore, in all such cases removal of the tonsils and the adenoids is indicated.

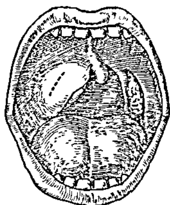
The whole of the tonsil should be removed within its capsule

(enucleation). This can be done either by dissection with scissors and forceps or by a special manœuvre with the guillotine. Bleeding may be controlled by the guillotine which has a special blunt blade, or by seizing the spurting vessel, usually in the lower part of the anterior pillar of the fauces, and ligating it. Haemorrhage may be free at first but usually quickly ceases. When the tonsils have been removed the adenoids are scraped off the nasopharyngeal wall by means of an instrument called an adenotome. The operation must be done with care so that no injury to the Eustachian cushion or the soft palate takes place. The general health of a child quickly improves when obstruction to the nasopharynx has been removed.

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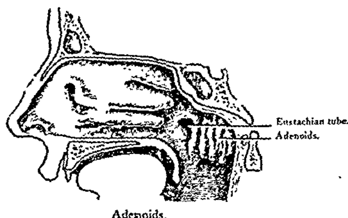
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The whole of the tonsil should be removed within its capsule

Teratomata sometimes grow from the base of the skull or nasopharynx. They are seen in babies and are usually pedunculated tumours which contain representatives of the three layers of the foetus (fat, connective tissue, cartilage, bone). They are covered with skin on which, perhaps, hairs are growing. They cause difficulty in swallowing and obstruction to breathing. They are simply removed.

Lipomata are very rare tumours of the pharynx. They are stalked tumours which the patient can sometimes project into the mouth by coughing.

Nasopharyngeal Fibroma.—This is a very peculiar tumour which grows in children from the base of the skull. It is made up of a kind of vascular fibrous tissue and is seen usually at about 15 years of age. It causes destruction of neighbouring parts by pressure, but it never forms metastases. It may grow into the posterior nares and cause a great broadening of the face between the eyes, or perhaps will grow into the orbit causing exophthalmos, or into the antrum of Highmore, or upwards into the skull. It is liable to ulceration and very serious haemorrhage because it is so vascular. It may cause obstruction to the Eustachian tube and the consequent otitis media, and may also cause great pain by pressing upon the fifth nerve. Obstruction to breathing may be caused.

These tumours are very rare. If the patient lives after 25 years of age the growth has a tendency to shrink and may eventually disappear. This strange behaviour would appear to remove the growth from the class of true tumours, but it is convenient to retain the old name.

The actual nature of the condition is not known. Histologically the tumours resemble sarcomata. They are extremely sensitive to X-rays so that no operation should ever be performed on them unless X-rays have been tried and failed. Surgery is exceedingly dangerous because of the difficulty in controlling haemorrhage which may arise. But an incomplete removal will sometimes be followed by a shrinking up of the remnant of the tumour as though the body had put up an immune reaction against the pathological process and overcome it.

Sarcoma of the pharynx is usually a growth of the tonsil of the nature of a lymphosarcoma. The growth forms a swelling of the tonsil covered with mucosa and is associated with enlarged glands in the neck. Very frequently both tonsils are affected. The diagnosis is made by palpating a hard tumour of the tonsil which is not ulcerated and which is associated with glandular enlargement.

The treatment of sarcoma of the tonsil is best carried out by radiation. The growth may shrink rapidly giving great relief to the patient, but it invariably returns.

relief follows this operation. Timely administration of penicillin may suppress the infection, making an operation unnecessary.

In a few months, after the acute inflammation has subsided, it is usually wise to remove the tonsil.

Retro-pharyngeal Abscess.—This is an abscess situated behind the pharyngeal wall between it and the spinal column. There are two varieties of abscess—the acute and the chronic.

Chronic retro-pharyngeal abscess is either a tuberculous abscess in a retro-pharyngeal lymphatic gland, or a tuberculous abscess which is due to caries of the upper cervical vertebrae, in which case the pus lies behind the prevertebral fascia. Such chronic abscesses should not be opened from the mouth. A large abscess of this kind will spread laterally and form a fluctuating swelling in the neck. It is by this lateral route that it should be approached. In doing so the carotid sheath with its contents is pushed forwards, and the space in front of the spine opened by a blunt-nosed Spencer-Wells forceps. When the pus has been evacuated the wound should, as a rule, be sewn up without drainage.

Acute retro-pharyngeal abscess is due to a pyogenic infection in a lymphatic gland situated behind the pharynx. This lies in front of the prevertebral fascia. The gland is not median in position but situated to one side. Its enlargement may be due to infection from adenoids or tonsils or a wound by a foreign body. It forms a projection on the back wall of the pharynx, to one side of the middle line, and is tender on pressure, covered by smooth hyperaemic mucous membrane. It has a fluctuant feel on palpation. The abscess is seen, as a rule, in children. They have a high temperature and show considerable distress. They are unable to swallow properly, whilst if it is large there may be some difficulty in breathing. It is necessary to open this abscess from within the mouth but precautions should be taken that the septic material is not inhaled into the lungs. For this reason it is sometimes advised that the operation should be done without a general anaesthetic. However, there is no real danger in the use of an anaesthetic if the incision is made when the cough reflex is present, and the head of the patient is kept lower than the rest of the body, so that the pus which escapes runs out of the mouth and nose. Here also penicillin should be given.

Tumours of the Pharynx

Meningoceles are occasionally seen projecting from the base of the skull into the pharynx. They are swellings which increase in size when the child cries.

both sides the radiation can be directed on to the growth from opposite directions. The plaques are removed at the end of 6 days.

Diverticulum of the Pharynx

A diverticulum sometimes forms at the back of the lowest part of the pharynx, just above the beginning of the oesophagus. Formerly these diverticula were described as pulsion diverticula of the oesophagus. In reality, the protrusion occurs through the inferior constrictor of the pharynx. The lowest fibres of the constrictor run circularly around the pharynx from one cricoid cartilage to another. Just above this lowest point fibres run from each side obliquely upwards to meet in the middle line, so that a small triangular area is left on the posterior aspect of the pharynx, imperfectly protected by muscle tissue. It is through this area that protrusion of the pharyngeal mucosa takes place and a pouch is formed. These diverticula attain quite a large size and, as they develop, project downwards into the left side of the neck. The cause of this protrusion is not known, but it occurs just above the upper end of the oesophagus at the entrance of which there is naturally a spasmodic muscular contraction, very evident when oesophagoscopy is performed. Should it be abnormal in intensity, or relaxation be delayed during deglutition, the pressure of swallowing might cause the mucous membrane of the pharynx to bulge through the weak spot above it.

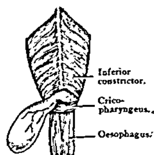


Diagram to show how a pharyngeal pouch is thrust out between the lower transverse fibres (crico-pharyngeus) and the more obliquely running fibres of the inferior constrictor muscle. View from behind.

There are no symptoms whilst the diverticulum is small but when it increases in size the opening into it allows free access to swallowed food, so that during a meal the pouch sometimes fills up. The protrusion at the side of the neck is actually visible to the patient and he is able, by pressure, to force the contents of the food up into his mouth. When he does this he finds that there are remnants of food which he may have taken several days before and which have remained undigested. When the pouch is distended it presses upon the oesophagus and obstructs it. The opening into the pouch may be dragged into a more direct line with the pharynx than the opening of the oesophagus, so that the tendency of the food is to go into the pouch rather than down the gullet. The patient may suffer very greatly from loss of nutrition owing to his difficulty in swallowing.

If a barium meal be taken the pouch is easily demonstrable. It

Carcinoma of the Pharynx is found particularly on the tonsil and, less commonly, in the rest of the pharyngeal wall. It is a curious fact that carcinoma of the posterior wall of the hypopharynx behind the cricoid cartilage is almost confined to women, whilst carcinoma of the anterior part of the pharynx, around the larynx in the pyriform fossa, or the lateral wall of the pharynx, is very much more common in men. In women carcinoma of the pharynx may have been preceded by the Plummer-Vincent syndrome (page 258).

Carcinoma of the tonsil is seen in the form of an ulcer on the surface of the tonsil which has the characteristically hard base and hard raised margins. Non-tender indurated glands in the neck may confirm the diagnosis.

Carcinoma of the wall of the pharynx first makes itself evident by some abnormal sensation in the throat. It may be just a feeling of something being there, an irritation, or a little difficulty with swallowing. There is no pain in the early stages and no interference with respiration. Carcinoma of the pyriform fossa is very often so devoid of symptoms that the first thing noticed by the patient is a lump in the neck. Diagnosis of these growths is made by laryngoscopic examination or by means of the post-nasal mirror.

These growths of the pharynx are liable to invade the larynx and then give rise to alteration of the voice and perhaps dyspnoea. The treatment of malignant disease of the pharynx is difficult because of the inaccessibility of the growth, and the fact that very often the larynx is involved as well.

In the case of a tonsil the best method of treatment is excision of the ulcer by diathermy and the removal of the glands in the neck by open operation. Good results have been obtained in cases of early epithelioma of the pharynx by exposing the growth from the neck. Tracheotomy is first performed and then the glands in the neck removed. The side wall of the pharynx is exposed, the great cornu of the hyoid bone removed and also the posterior part of the ala of the thyroid cartilage. The laryngeal wall is then quite lax and the growth can be felt through it. The growth is excised, the pharynx closed by sutures, and the wound in the neck left widely open for drainage.

An alternative to excision is radium treatment. Very good results are being obtained by teleoradiotherapy with a bomb containing 1 to 4 gm. of radium. Another method which has been used with success is the implanting on the side wall of the pharynx, through a small incision at the front of the sterno-mastoid, a layer of dental wax in which radium needles have been embedded. This can be done through quite a small incision, and if the operation is carried out on

CHAPTER XXII

DISEASES OF THE NECK

Congenital Affections

Branchial Sinus.—In the embryo there are four gill depressions on the inner side of the pharynx which correspond with four external invaginations from the surface. Normally there is no actual gill cleft, the membrane between two depressions remaining intact. As the foetus grows the second branchial arch, that is, the arch in front of the second cleft, grows outwards and backwards and covers over the remaining depressions, forming what is known as the cervical sinus. This should disappear with the growth of the foetus but sometimes the remains of it persist. The commonest relic is a narrow sinus communicating with the exterior. The opening of this sinus is usually on the anterior border of the lower third of the sterno-mastoid muscle. It is usually a minute pin-point aperture in the skin which sometimes requires close scrutiny to determine its nature. Such a fistula may be only the remaining lower part of the cervical sinus but it may extend up the neck and communicate with the pharynx through the upper part of the second branchial depression. The inner opening is then in the fossa of Rosenmüller, just above the tonsil. In its course the sinus will run between the carotid arteries since the internal carotid represents the primitive artery of the third branchial arch, above the hypoglossal nerve, and above the glossopharyngeal nerve, which is the nerve of the third branchial arch.

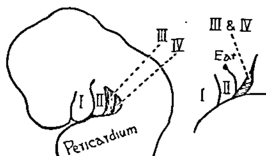


Diagram to show how the second branchial arch grows over the third and fourth arches. The right-hand diagram shows a later stage. Epithelial inclusions may arise in this way and develop into branchial cysts.

Clinically such sinuses may cause no trouble at all. Symptoms

may seem to lie in the line of the oesophagus. The lower border of the shadow of the pouch is rounded. It has not the conical projection which is characteristic of the shadow seen in carcinoma of the oesophagus. With the oesophagoscope the opening into the pouch can be seen.

When the pouch reaches any considerable size, surgery is demanded. It is easily dissected out of the neck and very often it can be removed, the opening into the pharynx sutured, the wall being in-turned. There is a certain risk with this procedure of infecting the fascial planes of the neck which do not resist infection very well. If this should happen it may lead to a septic mediastinitis, from which the patient will very probably die. It is therefore customary with some surgeons to perform the operation in two stages. In the first, the pouch is dissected clear from its surroundings, and without opening into it, it is sutured to the skin of the neck, being brought out as far as possible. After ten days or a fortnight, when a protective barrier of granulation tissue has formed round the neck and the sac, the pouch is removed and the opening sutured. The two-stage operation is less likely to be chosen now that the systemic administration of penicillin can, to some extent, lessen the risk of sepsis in the neck.


Skiagram of pharyngeal pouch after swallowing barium sulphate.

For small pouches sometimes no more is done but to dissect them free and suture the lower end upwards to the great cornu of the hyoid bone, so that the opening looks downwards and the sac drains into the pharynx. This operation, while attractive in conception, is not very satisfactory.

Plummer-Vincent Syndrome

The *Plummer-Vincent Syndrome* is seen in women. There are achlorhydria, dry and red tongue and pharyngeal wall, and a secondary anaemia. It is rather a rare combination of symptoms but it is of interest because occasionally it leads to a post-cricoid carcinoma of the pharynx. It is important, therefore, whenever this group of symptoms is met with that a full examination of the lower part of the pharynx be made to determine, or exclude, the presence of a carcinoma in this region.

stances it becomes very difficult to differentiate it from a tuberculous gland. Branchial cysts are quite simply removed through a transverse curved incision in the upper part of the neck.

Branchial Carcinoma.—Later in life carcinoma may grow in the neck from embryonic epithelium which has remained over when the cervical sinus was obliterated. These branchial carcinomata form hard masses in the lower part of the neck which invade the surrounding tissues and become fixed. They have all the characters of malignancy but no primary focus can be discovered. The diagnosis of branchial carcinoma should never be made until a complete examination of the pharynx, larynx and oesophagus has been carried out because carcinoma of the pyriform fossa is silent until secondary glands make their appearance.

The Thyroid Gland

Inflammatory Affections

Acute Thyroiditis.—This is an exceedingly rare disease of the thyroid gland but a few isolated cases have been described in association with specific fevers. As a secondary phenomenon it is more frequently seen. It may arise, for instance, when carcinoma of the oesophagus perforates into the neck. Infection may then enter the thyroid gland and cause an acute inflammation with suppuration. The result is very likely to be extreme dyspnoea, which necessitates a low tracheotomy.

Chronic Thyroiditis.—Under this heading are included three rare conditions: struma lymphomatosa (Hashimoto), struma fibrosa (Riedel) and struma granulomatosa (giant-celled chronic thyroiditis of de Quervain).

In struma lymphomatosa there are a diffuse degeneration of the acini of the gland associated with a general infiltration with lymphocytes and the formation of lymph follicles with an increase of fibrous tissue of fine texture. Colloid is scanty or absent. There is a diffuse enlargement of the whole gland, which is hard. The disease is rare, occurs in males and is of long standing. There may be vague symptoms of pressure upon the trachea, oesophagus or recurrent nerves and mild symptoms of hyperthyroidism. The gland is not adherent to neighbouring parts.

Struma fibrosa is also seen in men, though women predominate. The affected area of the gland is everywhere invaded with dense white connective tissue which causes compression atrophy of the acini. In some areas there may be colloid. Lymphocytes are

when they do arise, do not usually appear until adolescence or early adult life. Sometimes at the mouth of the opening there is a tiny nodule of cartilage under the skin. A slight secretion of mucus may occur but if the sinus becomes infected there will be an inflammatory reaction around it with the escape of pus. The sinus is lined with squamous epithelium in its outer part. In its inner part there may be columnar epithelium.

An uncomplicated branchial sinus does not require surgical treatment. When inflammation has set in it will be recurrent, so that removal of the tract is indicated. The approach to the sinus may be either through one long incision corresponding with the anterior border of the sterno-mastoid muscle, or through two curved transverse incisions, one of which includes the orifice of the sinus. As a rule, it will be found quite simple to dissect away the sinus and its wall, until the upper part is reached. As the surgeon approaches the pharynx the dissection becomes very deep; it goes above the glossopharyngeal nerve beneath the angle of the jaw. As a rule, it is possible by traction to ligate the sinus sufficiently near the pharyngeal wall for permanent relief to be attained. Occasionally the inner opening has been traversed by an eyed probe from the mouth and a ligature passed, which is sewn to the short cut upper end of the sinus. By pulling on this thread the upper stump has been inverted into the pharynx, ligated and removed.

Branchial Cyst.—Branchial cysts are the remains of the cervical sinus. Curiously enough, they have nearly always lost their connections with the pharynx and with the exterior. Only very rarely is there a communication with the pharynx, so that the patient, by holding his nose and forcibly expiring, can distend the cyst with air. A branchial cyst is very often lined with squamous epithelium and has a considerable amount of lymphoid tissue in its walls. It forms a rounded swelling in the upper part of the neck, below the angle of the jaw. It is seen, as a rule, in young adult life and is apt to be mistaken for a softening tuberculous gland. It is more flaccid than the ordinary cold abscess of the neck and it remains present for a long time and does not reach the skin in the way that a tuberculous gland does. Moreover, there is one large swelling without any accompanying smaller swellings.

The diagnosis can be rendered certain by aspiration, when a yellow fluid will be removed, which contains cholesterin crystals from the degeneration of desquamated epithelium. Sometimes branchial cysts become inflamed in the same way that lymphoid tissue in the pharynx does. This causes an exudation to be poured out into the cyst which will render it tender and tense. Under these circum-

which resembles the foetal thyroid before colloid has collected. These adenomata, composed of solid masses of epithelial cells, are designated foetal adenomata. When there are a number of adenomata in the thyroid gland the parenchyma between the growths may show the changes of parenchymatous colloid goitre. This combination is sometimes referred to as an adeno-parenchymatous goitre, or a nodular goitre.


Large adeno-parenchymatous goitre.

All these enlargements of the thyroid, which have been described, are grouped under the term simple goitre. Toxic goitre includes exophthalmic goitre (Graves' disease or Basedow's disease), and toxic adenomatous goitre in which symptoms of hyperthyroidism develop with simple adenomata. Malignant goitres include carcinomata of the thyroid, sarcomata and endotheliomata.

Goitres, therefore, may be classified as follows:

(a) *Simple:*

(1) Parenchymatous Goitre: Colloid. Vascular. Cystic. Fibrous.

(2) Adenomatous Goitre: Foetal. Colloid.

(b) *Toxic:*

(1) Exophthalmic Goitre (or Graves' Disease).
(2) Toxic Adenomatous Goitre.

(c) *Malignant:*

(1) Carcinoma.
(2) Sarcoma.
(3) Endothelioma.

Parenchymatous Goitre.—The cause of parenchymatous goitre is not fully known but it is a condition which occurs more especially in countries far removed from the sea-shore; for instance, it is endemic in Switzerland and in Derbyshire. Such places have one thing in common—a deficiency of iodine in the water. This is not the only factor in the production of goitre, because certain individuals escape. It is fairly certain that infection from drinking water plays its part. For in the same district individuals drinking from one supply may be

scattered about. The enlarged gland is very hard, but not nodular. One lobe only may be affected. The symptoms are usually of recent onset. Pressure-effects are always very pronounced, for the gland may actually surround the trachea or oesophagus, and be so alarming that a state of anxiety is set up which raises the metabolism. The gland becomes densely adherent to surrounding structures.

In struma granulomatosa there is a similar fibrosis with the presence of foreign body giant cells. The adhesions are not so prominent a feature. Pressure symptoms are mild.

The difficulty is to diagnose these conditions from malignant disease. It is rare for cancer to occur in a *previously normal gland.* A malignant tumour is nodular and irregular on the surface, whereas in these conditions the surface is smooth. In circumstances of doubt a biopsy should be done.

X-rays produce excellent results in struma lymphomatosa. Surgery is only necessary to relieve pressure-effects. The operation *may be followed by the necessity for thyroid by mouth. Hence* as little as possible should be removed.

X-rays may also do some good in giant-celled thyroiditis but in struma *fibrosa operation for the relief of pressure is necessary.* The adhesions to surrounding parts are so great that often only a strip of gland tissue can be safely taken away. This is sufficient.

Goitre (Bronchocele)

A goitre is an enlargement of the thyroid gland. If the enlargement is due to a simple hypertrophy of the gland substance, without change in its histology, we speak of a parenchymatous goitre. Such a *parenchymatous swelling is not very common* without certain changes, which are an increase in the size of the vesicles and the accumulation of colloid. Partitions between neighbouring vesicles may disappear, *leading to quite* large *spaces.* When this change has taken place the goitre is said to be colloid. If there is a great increase in the blood-vessels of the enlarged gland it is said to be a vascular goitre and if, as the result of secondary changes, fibrosis occurs the goitre is said to be fibrous. Hypertrophy of the gland may be localised, in which case we speak of an adenomatous goitre. These adenomata are very apt to be multiple and scattered through the whole substance of the gland. They are encapsuled tumours and are of two types. In one the structure is similar *to that of the thyroid tissue* itself, that is, it is composed of vesicles containing colloid which, however, may be very much increased in size and develop into large cysts (cystic adenoma). In *the other,* the adenoma is made up of tissue

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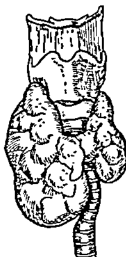
affected whilst those drinking from another go free. If it is associated with deficiency of iodine, then goitre appears. The incidence of enlargement of the thyroid has been reduced very considerably in places where it is endemic by giving iodine to the population, either by putting it into the water or by mixing potassium iodide with the common salt which is sold commercially. This prophylactic treatment is not altogether desirable because it means the administration of iodine to some people suffering from hyperthyroidism which, when it is carried out continuously, renders them worse.

Parenchymatous goitre occurs more commonly in women than in men. There is a physiological enlargement of the thyroid gland which sometimes occurs at puberty, when there is need for increased thyroid secretion, and also in pregnancy. The puberty goitre forms a symmetrical swelling in the neck which causes but little trouble and usually shrinks down to normal as the child grows, but if she lives in a place and under the conditions conducive to the formation of goitre, pathological changes may take place which prevent this shrinking. The gland is gradually transformed into a colloid goitre, which may become cystic, fibrous or vascular. Under these circumstances the gland does not perform its function properly. Sufficient thyroxin is not brought into the circulation, the basal metabolism is below normal and the gland continues to increase in size. This enlargement does not usually remain quite symmetrical, one lobe increasing in bulk more than the other, so that the trachea is pushed out of the median line towards the smaller side. Not only is it pushed laterally but it is compressed so that in cross-section it becomes an antero-posterior slit instead of a circle. This narrowing of the trachea causes the main symptom of parenchymatous goitre, namely dyspnoea, which is evident on exertion. When the goitre gets very large the patient finds it impossible to sleep lying down; she has to sit up in order to get her breath. Sometimes the goitre enlarges downwards into the thorax behind the sternum. When it does this it is dangerous because of the rigid bony walls by which it is enclosed. In this case the trachea may be compressed antero-posteriorly, and the dyspnoea is more severe, for, on exertion, the gland swells and there is no room for its increase in size. At the same time the innominate veins may be compressed so that the superficial veins over the front of the sternum and at the root of the neck become enlarged. In rare cases a projection of the gland lies within the thorax but can be forced upwards by coughing (plunging goitre), though in this case the projection is usually adenomatous in nature.

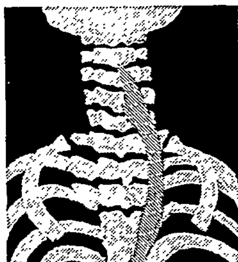
The symptoms of parenchymatous goitre are almost solely due to pressure on the trachea. Quite rarely, the oesophagus is pressed

upon. The recurrent laryngeal nerve is not affected by a simple goitre.

Puberty goitre requires no treatment. It should be left alone; the patient needs all the thyroid tissue she has and assistance should be given to the mobilisation of the thyroxin produced by it. This can be done by administration of iodine, either potassium iodide gr. v t.d.s. or Lugol's solution (5 per cent I in 10 per cent KI) ♏v in milk twice daily. The gland can often be induced to shrink by



The flattening and deviation of the trachea caused by a goitre.



Deviation of the trachea produced by a large goitre. As shown by skiagraphy.

giving small doses of thyroid extract; at first, ½ gr. twice daily, later 1 gr. twice daily; but care should be taken that hyperthyroidism is not induced by continuing the drug too long. At the first sign of a persistently rapid pulse the drug should be stopped.

When the gland has become pathological in structure and is causing dyspnoea, operative treatment is required. It is best to remove a segment of the gland from both sides of the neck, the larger piece being taken from the side on which there is the greater enlargement of the gland. This side should be operated upon first or there is danger of causing the trachea to collapse further.

Adenomatous Goitre.—Adenomata appear in the thyroid gland in early adult life, as a rule. They only occur uncommonly in children. They appear as rounded isolated nodules in the thyroid, which are known to lie in this structure because they move upwards with the larynx on swallowing, being underneath the pretracheal fossa which fixes the thyroid gland to this structure. Adenomata are frequently multiple. In places where goitre is endemic the diffuse enlargement of the thyroid very frequently passes into a condition in which a

number of adenomata develop within its substance, the adeno-parenchymatous, or nodular goitre referred to above. Certain pathological changes are apt to occur in adenomata which may become cystic by the disappearance of some of the partitions between the enlarged acini. Into these cysts haemorrhage may occur. If the haemorrhage be very abundant a large swelling may appear and give rise to acute dyspnoea from pressure upon the trachea and, if the walls of the trachea have already been softened, lead to death by suffocation. In other cases the nodules become fibrous and ultimately calcified. True ossification has been seen in thyroid adenomata. A plunging goitre, as mentioned above, is usually an adenoma of the thyroid.

Operative treatment is always indicated in thyroid adenomata because of the risk of a haemorrhage and sudden dyspnoea, because the adenomata, later on in life, will continue to increase in size, because, usually *after 30 years of age, the adenoma may so change that hyperthyroidism* may appear (toxic adenoma) and, finally, because most examples of malignant disease of the thyroid arise in adenomata. Isolated adenomata can be shelled out of their capsules, but when there are multiple adenomata in association with pathologically changed intervening gland tissue, it is much better to carry out a partial resection of the gland, an operation which should be done, as a rule, on each side.

Should a patient have a sudden attack of dyspnoea from haemorrhage into an adenoma, an attack which threatens his life, the treatment *is rapidly to expose his thyroid gland, divide the infrahyoid* muscles and deliver the gland on to the surface of the neck. His dyspnoea will be immediately relieved and his life saved. There will then be plenty of time to carry out the resection of the gland.

Toxic Goitre.—Under this term are included true exophthalmic goitre and toxic adenomata.

The true nature of exophthalmic goitre is not known. It is suspected that the thyroid gland is not primarily at fault, but changes take place which maintain the symptoms of the disease, which is essentially a condition in which metabolism of the body takes place at an enhanced rate so that all the activities are increased. It is a condition more common in women than in men and its onset has some connection with mental disturbance, particularly a sudden fright. How psychical changes cause an increase in the activity of the thyroid gland is not definitely known, but the hypothalamus, the seat of the emotions, has nervous connections with the pituitary, whilst the anterior lobe of the pituitary is known to stimulate both the suprarenals and the thyroid gland. The suprarenals in their turn produce

a secretion which excites the secretion of the thyroid substance. In exophthalmic goitre there are definite structural changes in the gland. The epithelium increases at the expense of the colloid so that the vesicles become solid masses of cells.

The symptoms of the disease are not due to simple excess of thyroxin in the blood because they cannot all be reproduced experimentally by the injection of pure thyroxin. This fact, in addition to the microscopic changes described above, points to there being a disordered function of the gland so that there is probably a qualitative change in the secretion as well as an increase of it. The result of this dysthyroidism is that the patient's tissues burn up at a greater rate than normal. He becomes thin and wasted. This loss of weight is very characteristic. At the same time, the patient in an effort to keep up his condition has a voracious appetite. There is hypersensitiveness of the sympathetic system. The patient is emotional. Flushing easily occurs and the heart-beat is accelerated. This increase of the pulse rate is seen to be one of the most serious symptoms of the disease when it is realised that a rise in the pulse rate of only ten beats a minute means an additional 14,400 beats in 24 hours. These additional heart-beats take place chiefly at the expense of diastole, that is, during the natural period of rest and recuperation for the heart muscle. When we think that a pulse rate of 120 continuously day and night is a not unusual feature of the disease it can be readily understood what an immense strain is thrown on the reserves of the heart and that myocardial degeneration is the result if the disease lasts for any considerable time. The rapid heart-beats are recognised by the patient as palpitation, which is apt to keep him awake at night and becomes much worse on exertion. Cardiac weakness also causes him to suffer from dyspnoea. Hyperactivity of the sympathetic causes unusual proneness towards sweating. His hands are always moist whatever the external temperature is and the dilatation of the peripheral vessels renders him very sensitive to heat. He never feels cold. The hair tends to fall; a very characteristic symptom of which women early take note. The eyeballs are pushed out of the orbit. This exophthalmos is due partly to spasm of Müller's muscle in the orbit owing to sympathetic activity, but when it has been present for a considerable time an anatomical adaptation occurs in the form of the deposition of fat, which may bring about a permanent proptosis to some degree. When the patient looks downwards the upper lids lag behind the cornea (von Graefe's sign). The retraction of the upper lid, so that the white sclerotic is seen above the cornea when the patient looks straight forwards, is Stellwag's sign. Owing to deposition of fat in the orbits there may be some difficulty in con-

vergence of the eyes when looking at a near object (Moebius' sign). The exophthalmos in certain cases is so great that the eyelids cannot cover the cornea during sleep and there is great danger in these cases of ulceration occurring which may lead to loss of the eye.

Just as his bodily activities are increased in intensity so the patient is mentally more alert. He is busy, worries and gives way to anxiety, but with all this he is not able to concentrate his attention. In severe cases there may be diarrhoea which adds to the wasting. The blood may show some anaemia with a lymphocytosis.



Exophthalmic goitre. It shows the enlarged thyroid gland and the retracted upper lids.

Exophthalmic goitre is a disease with a prolonged course. The symptoms vary in intensity. They follow a wave whose length is about one year, that is, the symptoms increase in gravity during the first six or seven months and then begin to recede during the next six months, to rise again in subsequent waves of intensity.

The thyroid gland is enlarged but the amount of enlargement does not bear a direct relation to the severity of the symptoms. It is not usually sufficiently great to cause dyspnoea from pressure upon the trachea. The consistency of the gland is much harder than that of a parenchymatous goitre. A thrill can sometimes be felt over the carotids in the neck and a bruit can be heard over the gland.

If left to themselves approximately 50 per cent of patients return to normal but usually with a damaged heart muscle. The mortality from the disease is estimated as 25 per cent.

Hyperthyroidism may come on at any time in a patient who has adenomata in his thyroid and is due to changes in these tumours. In this form of hyperthyroidism some of the symptoms present in an exophthalmic goitre are wanting, particularly the exophthalmos and the intestinal symptoms, but the toxaemia and the hyperthyroidism of adenomata have a greater effect upon the heart muscle than has an exophthalmic goitre. Auricular fibrillation may occur in both diseases but it is more common in toxic adenomata.

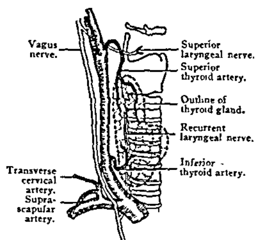
Treatment.—Since exophthalmic goitre is a disease accompanied by a high mortality and when cure occurs it takes considerable time during which cardiac degeneration may occur, it is advisable in most cases to recommend operative treatment. This statement may have to be modified since the discovery that thiouracil will lower metabolism, without much risk. Judgement on the final place this drug will take in the treatment of hyperthyroidism must be reserved for the

present. Meanwhile by removing a large part of the gland ($\frac{3}{4}$ to $\frac{7}{8}$) the symptoms can be ameliorated, the nervousness disappears and the pulse rate falls so that the strain is taken from the heart within a few weeks instead of several years. The advantage to the patient in this way is very great but, on the other hand, there is a definite mortality associated with the operation. It is not easy to say exactly what this mortality is, because cases differ so very greatly in the severity of their symptoms and consequently in their reaction to operative treatment. Published statistics include large numbers of mild cases in which there is very little risk of death from operation. In the bad cases, particularly those with severe nervous symptoms, the patient may be unable to withstand the disturbance produced by a thyroidectomy. After the operation he passes into a state called acute thyroidism. In this the heart beats more and more quickly until it becomes uncountable and the temperature rises steadily until it reaches a very high level. Delirium, agitation and restlessness come on which it is sometimes impossible to control. Acute thyroidism of a mild degree is fairly common after an operation, but when it is severe the patient succumbs from exhaustion and cardiac failure. Nevertheless, if proper precautions are taken the mortality from operative treatment is very much less than if the disease is allowed to run its course. The precautions which are necessary are the choice of the ideal time for excision of the gland, a preliminary period of rest in bed and the administration of iodine.

It has been already mentioned that the symptoms of exophthalmic goitre wax and wane in their intensity. During the first six months of the second year of the disease there is usually a subsidence of the primary initially bad symptoms. This is a period when operation can be undertaken with less risk. The patient should not be subjected to an operation during a time when his condition is getting progressively worse and particularly when mental symptoms are severe. Rest in bed will bring about, by itself, an extraordinary change for the better. It is advisable to have every patient in bed for a fortnight before removing the thyroid gland. During this time he should receive iodine in the form of Lugol's solution (Iodine 5 per cent in potassium iodide 10 per cent) 5 minims twice daily, increased to 10 minims twice daily during the second week. If under this treatment the pulse rate fails to fall or rises whilst there is further loss of weight the outlook for operation is poor. A crisis is likely to be precipitated. The failure of the basal metabolic rate to fall with rest is also a very unfavourable sign. The heart can also be controlled by quinidine and digitalin. If a patient has so much cardiac degeneration that he is oedematous, or if he shows very great mental instability, the risk

of operation is great, but if his heart shows simple auricular fibrillation, this is no contra-indication.

In very bad cases it is sometimes necessary in a preliminary operation to cut off some of the blood-supply of the gland. Usually the upper pole of the gland is ligated, but no result is obtained if only one upper pole is operated upon as the communication between the two superior thyroid arteries on opposite sides is so free. If, however, the superior thyroid and the inferior artery on the one side are tied simultaneously, the gland can be observed subsequently to shrink and the patient will benefit. The great objection to this operation is that at the subsequent thyroidectomy the gland may be difficult to dislocate, owing to the fibrosis which has occurred from the disturbance of the tissues necessary to carry out the operation, whilst anastomotic vascular channels have been opened up which are not so easy to secure as their situation is not accurately known. Also, now that preliminary iodine treatment is carried out it is only rarely necessary to do a preliminary ligation.



The arrangement of the superior and inferior thyroid arteries and the recurrent laryngeal nerve.

After the operation, should symptoms of hyperthyroidism occur, the patient should be given digitalin hypodermically and saline solution by rectum or, if necessary, intravenously. Plenty of drinks by mouth, where it is possible, should be given, and morphine and bromides for the restlessness. It is a debatable point whether iodine is useful in controlling the symptoms of post-operative hyperthyroidism. It is also a debatable point whether it is advisable to open up the wound with the object of washing away accumulated thyroid secretion. The drainage tube will usually provide an exit for this.

Toxic Adenomata are not always influenced by the administration of iodine. Though they may be accompanied by auricular fibrillation the results of operative treatment are extremely good, the fibrillation disappearing within 48 hours.

Malignant Goitre.—Sarcoma and endothelioma of the thyroid gland are of very rare occurrence and have no characters distinguishing them from the more usual carcinoma. This latter disease, itself, is rather rare. It occurs in middle age and very often in those patients who have had an adenoma for many years. It is said to be a more

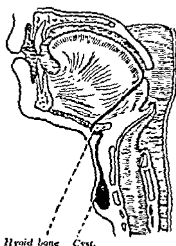
common complication of the foetal type of adenoma. It forms a localised hard tumour in the substance of the thyroid gland which moves with deglutition. Whilst it is confined within the capsule of the thyroid it is not possible to distinguish it from a calcified adenoma of the gland without the help of X-rays, but when it spreads beyond the capsule it invades the neighbouring structures, the pretracheal muscles in front, whilst behind it encroaches on the recurrent laryngeal nerve, causing laryngeal paralysis and hoarseness. If it spreads back further it may cause a neuritis of the transverse cervical nerve or the great auricular nerve or the descending branches of the third and fourth cervical nerves, so that severe pain is felt in the areas of distribution of these nerves. A malignant thyroid surrounds the carotid vessels whereas an innocent enlargement of the thyroid gland pushes them backwards so that they come to lie in the posterior triangle of the neck. There may be secondarily infected malignant glands accompanying the growth. There is a peculiar type of malignant thyroid which, in histological structure, is similar to normal thyroid tissue but which gives rise to metastases, particularly in the bones. This malignant colloid goitre, as it is called, is an exception to the rule that malignant growths subserve no function of use to the body, for after removal of such a malignant goitre, myxoedema has occurred, which has been relieved on the growth of a metastasis in a bone, the removal of which metastasis has again given rise to myxoedema.

The *treatment of malignant goitre is excision of the whole lobe* of the gland, which contains the growth. This is only possible when the carcinoma is confined within the limits of the capsule of the gland. If there are distinctive signs of malignant disease, such as recurrent paralysis or neuralgia of the neck, the condition has usually proceeded beyond the possibility of surgical relief. That is why many malignant thyroids have been removed without a diagnosis having been made beforehand.

Thyroglossal Cyst

A thyroglossal cyst is an accumulation of fluid in the epithelial tube which grows down from the floor of the pharynx behind the tuberculum impar to form the thyroid gland. Thyroglossal cysts are seen in children or young adults and are situated in front of the larynx and below the hyoid bone, sometimes a little to the left of the middle line. They are spherical, fluctuating tumours not attached to the skin, but having attachments to the hyoid bone, a connection which can very often be felt by pinching up the cyst between the thumb and fingers and trying to drag it away from this bone. The

attachments also can be demonstrated by *making the patient* protrude his tongue, when the cyst will be seen to rise in the neck. Sometimes a thyroglossal cyst becomes inflamed and suppurates.



Thyroglossal cyst and its relation to the tongue and hyoid bone.

Thyroglossal Sinuses are also seen which have their external opening in the middle line of the neck above the level of the isthmus of the thyroid gland. The sinus runs upwards behind the hyoid bone into the substance of the tongue and may *actually reach to the foramen caecum*. There may be some lymphoid tissue outside the epithelial lining and in the upper part there may also be thyroid tissue. In fact, this may be of such a size as to form an obvious tumour in the tongue (lingual thyroid, see page 222). As a rule, however, the sinus does not reach *further* upwards than the hyoid bone. Attacks of inflammation may occur, giving rise to a purulent discharge.

Thyroglossal cysts and thyroglossal sinuses should be removed. A sinus is very liable to appear again, but this can be avoided if the middle part of the hyoid bone, to which the tract is very firmly attached, be removed with it. The operation is usually carried out through a small transverse incision which surrounds the external opening.

Torticollis

Torticollis is the name given to the deformity which results from contraction of the sterno-mastoid, by which the chin is turned to the opposite side and the head is flexed laterally to the same side as the shortened muscle.

There are the following varieties of torticollis:

1. Congenital.
2. Symptomatic.
3. Spasmodic.

Congenital Torticollis becomes evident in children of 3 or 4 years of age. There has often been a history of some difficulty of birth with perhaps the formation of a haematoma in the affected sterno-mastoid. There is some dispute as to whether these haematomata do give rise to torticollis in after-life, but there seems to be no doubt that they have occurred more commonly in cases of torticollis than in normal children. Since the change in the sterno-mastoid itself is very

similar to that in Volkmann's ischaemic paralysis of the forearm, it has been supposed that the condition may be the result of some interference with the sterno-mastoid branch of the superior thyroid artery at birth, either due to an acutely flexed position of the head, or to injury by forceps. It is difficult to see how this artery could be compressed by either of these means, and the hypothesis that it is due to venous obstruction is more tenable. Whatever is the true explanation the sterno-mastoid muscle is fibrous in structure, atrophied, and ceases to grow at the same rate as the muscle on the other side of the body, so that the head is forced into the characteristic position. When the condition has lasted for any time there results a secondary adaptive contraction of the deep cervical fascia and of the scalenus anterior muscle on the same side.



Congenital torticollis.

Torticollis is easily recognised because the muscle stands out as a visible cord in the neck, preventing reposition of the head into its proper place. In established cases there is also slower growth of the face on the same side so that there is an asymmetry of the features, and in long-standing cases also there are compensatory scoliotic curves in the spinal column.

The treatment of the condition is manipulative for minor degrees, and operative for the more pronounced deformities. Stretching of the contracted structures by manipulations, with perhaps the wearing of a cap at night with a webbing strap fastened to a band round the chest to correct the deformity, may be sufficient to overcome it. In other cases fixation and plaster of Paris for correcting the position are desirable. When the deformity is at all pronounced it is better to operate.

An incision is made above the clavicle, both heads of the sterno-mastoid are divided just above their origin, as also the deep fascia of the neck and, if necessary, the scalenus anterior. The open division of the muscle is preferable to subcutaneous division because large veins of the neck lie close beneath it. The operation of dividing the muscle at its insertion into the skull so that the scar is concealed is wanting in efficiency because it does not allow the surgeon to deal with the contracted cervical fascia or the scalenus anterior. The head may be fixed in the over-corrected position in plaster of Paris until the wound is healed, when remedial exercises should be instituted to maintain the correction.

Symptomatic Torticollis is a temporary contraction of the sterno-mastoid which may be due to a myositis of the muscle itself (rheumatic torticollis), or to irritation of the spinal accessory nerve by some inflammatory condition of the neck, such as infected glands. It is a temporary affection and its treatment is that of myositis (page 545) or of the inflammatory condition in the neck.

Spasmodic Torticollis is a curious condition in which the sterno-mastoid goes into spasm, which is tonic in character but subject to intermittent spasms. The patient with spasmodic torticollis will be seen constantly striving to drag his head gradually from the abnormal position round to the normal attitude. When he has almost succeeded in doing this his control suddenly vanishes. His head is jerked back into the abnormal position. This goes on the whole of his waking hours and is rendered worse by excitement. It becomes quite impossible for him to work.

The disease is an affection of the cortical area of the brain. Many operations have been devised for its cure. It is not sufficient to divide the sterno-mastoid, because in this case the sterno-mastoid acts in association with the rotators of the head of the opposite side. A large piece of the sterno-mastoid has frequently been removed without giving relief. The spinal accessory nerve has also been divided, but here again it is necessary to divide in addition the dorsal branches of the second and third cervical nerves on the opposite side of the body. All operations for spasmodic torticollis are unsatisfactory. They bring relief for a time only and if nerves have been divided there is a permanent crippling. There may be a recurrence on the opposite side of the body. Sometimes other muscles are involved which do not force the head into the characteristic position but laterally towards the shoulder or straight backwards.

Since the disease has a cortical origin it is better to employ measures which affect cortical activity. Fixation of the head in the normal position in plaster of Paris under anaesthesia will sometimes give rise to a cure. It is wiser to try this measure before considering any open operation, as relapse is almost invariable.

Injuries to the Neck

Blunt force is liable to cause a fracture of the thyroid cartilage or of the hyoid bone. In both cases the results are a haematoma in the upper part of the neck which is surrounded by oedema, which may lead to obstruction of the larynx and necessitate a tracheotomy. If the fractured cartilage or bone penetrates the mucosa of the larynx or pharynx, haemorrhage may cause the patient to cough up blood.

There is tenderness either over the hyoid bone or the thyroid cartilage, and compression of these structures may be accompanied by a crepitus. There are pain on swallowing and sometimes difficulty.

There is no treatment except immobilisation of the neck in bed between sandbags, and tracheotomy, should dyspnoea become too acute.

Cut Throat.—In attempts at suicide by cutting the throat the individual usually throws his head so far back that the great vessels of the neck are protected by the sterno-mastoid muscle, and thus it is the carotid arteries or the internal jugular vein are very seldom divided. If the patient is right-handed the incision begins on the left-hand side and tails off towards the right. Small arteries, such as the superior thyroid, and veins, such as the external jugular, are frequently severed and give rise to profuse haemorrhage. There is also likely to be bad haemorrhage if the cut should be made high up above the hyoid bone into the root of the tongue. A more frequent complication is the opening of the air passages. The cut may go through the thyrohyoid membrane, into the thyroid cartilage or open the trachea. If the isthmus of the thyroid is divided, the haemorrhage is again likely to be great. The great risk in these injuries is that blood should enter the trachea and suffocate the patient, so that the primary treatment must be directed towards preventing this, which may necessitate the performance of a low tracheotomy. Once the free respiration of the patient is ensured, then attention can be directed to divided structures in the neck.

The wound should be freely opened, disinfected with some antiseptic such as cetavlon or ordinary soap, divided arteries and veins sought for and their ends ligated. Haemorrhage from arteries and veins may have stopped temporarily by the formation of a clot, which clot may be dislodged during the manipulations. When large veins in the neck are divided the risk to the patient is not that of haemorrhage from the upper end, although this may be great, but the suction of air into the lower end (air embolism). If a sufficient quantity of air is sucked into the right side of the heart it is churned up with the blood which is there into a compressible froth. This mixture of air and blood prevents new blood entering the heart and is not itself expelled because of its elasticity. The result is that the circulation is stopped and the patient dies. Should a large vein be injured near the root of the neck during an operation it will be recognised by the gurgling sound which occurs when air enters the vessel. The wound should be immediately flooded with a saline solution to prevent the further entrance of air. Then the central end of the vessel can be seized in a clamp and ligated. If the air passages have been opened in a suicidal attempt they should be carefully sutured. Under these

circumstances it is usually wiser to leave a tracheotomy tube in position for a few days. Divided muscles are repaired and the skin wound sutured. Drainage must always be provided for. The patient is likely to suffer from pneumonia. Stab wounds of the neck are dangerous because they may penetrate large vessels or the air passages. If the entry wound is small the haemorrhage may soon cease with the formation of a large haematoma in the tissues of the neck. This haematoma, by its size, may press upon the air passages and cause dyspnoea. A wound of the trachea may lead to emphysema of the tissues of the neck. These wounds must be treated by enlarging them as soon as possible, finding the bleeding vessels and ligating them (see page 61). The wound must always be drained because there is the risk of infection spreading from outside or from the open trachea into the spaces of the neck, down to the mediastinum.

For injuries of the thoracic duct see page 85.

Ludwig's Angina

Ludwig's angina of the neck is a cellulitis which spreads from the floor of the mouth, often arising in sepsis round a tooth. In the floor of the mouth it invades the tissues between the mylohyoid and

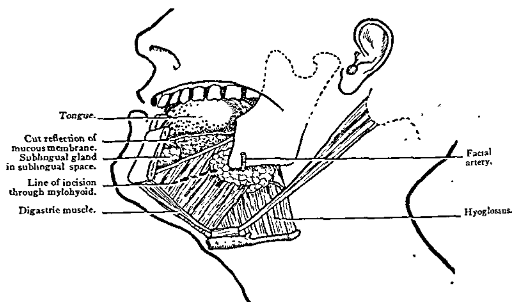


Diagram to show how in Ludwig's angina the sublingual space is drained by an incision *through the mylohyoid muscle.*

the genio-hyoglossus muscles and thence passes into the submaxillary triangle of the neck. The patients have a high temperature and rapid pulse. There is oedema of the floor of the mouth, in which there is a hard swelling which pushes the tongue towards the roof of the

mouth and sometimes makes it protrude. There is also to be felt a hard brawny swelling beneath the chin. The condition is a serious one because the inflammatory reaction may spread backwards to the root of the tongue and cause oedema of the glottis and death by suffocation. Septic thrombosis of the facial vein with pyaemia, necrosis of the lower jaw and fistula formation between the mouth and skin in the submaxillary region may also occur.

Usually these complications can be averted and the oedema caused to subside by hot fomentations and penicillin. If the signs do not abate it will be necessary to make an incision in the jaw parallel with the body of the mandible, on one or both sides. The incision must cut through the mylohyoid fibres so as to give exit to the exudation which lies deep to the muscle. Should it become necessary tracheotomy must be performed. Staphylococcal antitoxin should be administered.

New Growths of the Neck

Lymphangiomata are congenital formations which increase in size after birth. They form soft swellings in the neck which are not translucent nor compressible. They are made up of a series of dilated lymphatic spaces and have very ill-defined margins. They send out processes between the structures of the neck and are apt to grow downwards behind the clavicle into the axilla, where they may form large swellings. As they grow the partitions between the cysts become thin and disappear so that large spaces are formed. When this happens the condition is said to be one of cystic hygroma of the neck or axilla. These tumours are translucent.

It is difficult to dissect out hygromata of the neck because the boundaries are so ill-defined and also the processes spread finger-like between the various structures of the neck. Frequently the bulk of the tumour can be removed but outlying processes are left.

Lymphangiomata are apt to undergo attacks of inflammation, which cause them to become very much bigger temporarily. There are accompanying fever and tenderness of the tumour. When the inflammation subsides many of the cavities are obliterated by the subsequent fibrosis.

Haemangiomata of the neck are also congenital tumours, which are soft, compressible and non-translucent. As a rule they can be removed by surgical measures.

Lipomata of the neck are seen in three varieties. A diffuse lipoma of the neck is a deposit of fat in the subcutaneous tissue which is not limited by a definite capsule. Very large masses may form

circumstances it is usually wiser to leave a tracheotomy tube in position for a few days. Divided muscles are repaired and the skin wound sutured. Drainage must always be provided for. The patient is likely to suffer from pneumonia. Stab wounds of the neck are dangerous because they may penetrate large vessels or the air passages. If the entry wound is small the haemorrhage may soon cease with the formation of a large haematoma in the tissues of the neck. This haematoma, by its size, may press upon the air passages and cause dyspnoea. A wound of the trachea may lead to emphysema of the tissues of the neck. These wounds must be treated by enlarging them as soon as possible, finding the bleeding vessels and ligating them (see page 61). The wound must always be drained because there is the risk of infection spreading from outside or from the open trachea into the spaces of the neck, down to the mediastinum.

For injuries of the thoracic duct see page 85.

Ludwig's Angina

Ludwig's angina of the neck is a cellulitis which spreads from the floor of the mouth, often arising in sepsis round a tooth. In the floor of the mouth it invades the tissues between the mylohyoid and

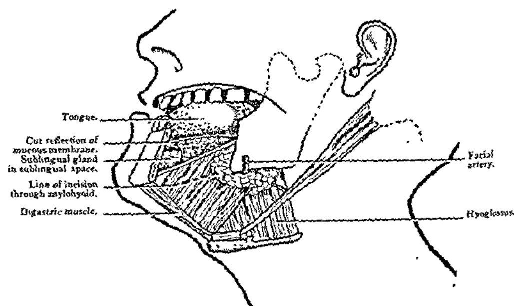


Diagram to show how in Ludwig's angina the sublingual space is drained by an incision through the mylohyoid muscle.

the genio-hyoglossus muscles and thence passes into the submaxillary triangle of the neck. The patients have a high temperature and rapid pulse. There is oedema of the floor of the mouth, in which there is a hard swelling which pushes the tongue towards the roof of the

place. They form soft resilient swellings above the clavicle which become larger on forcible expiration.

Pneumatoceles are hernias of the mucous membrane of the air passages in the region of the larynx. They form soft swellings in the neck which can be distended by the patient if he squeezes his nostrils and forcibly expires.

Carotid Body Tumours.—These are new growths of the carotid body which lies at the bifurcation of the common carotid artery in the neck.

The tumours which grow are solid rounded nodules of very slow development situated at the level of the thyroid cartilage. They are called "potato" tumours. If they are allowed to grow they surround the two carotid vessels, press upon the oesophagus and larynx, and perhaps on the sympathetic and vagus nerves.

Removal of such tumours is sometimes only possible if the three great arteries of the neck are ligated and portions of them removed in association with the tumour. It is, however, possible to remove them in the early stage without sacrificing the carotid vessels. The ligation of all three vessels is a serious step (see pages 63 and 67). Eight out of ten carotid body tumours are benign in nature.

Lymphosarcoma of the neck affects the lymphatic glands. It is nearly always bilateral and associated with lymphosarcoma of the tonsil. The growth in the tonsil may be quite small but the mass in the neck is large. There may be deposits in both tonsils. The lymphatic glands are separate at first but soon become matted together. Their growth is rapid.

The only treatment is radiation by X-rays, which will often cause subsidence of the swelling but will not permanently cure the patient.

True Sarcoma of the neck may grow from the lymphatic glands or from the connective tissue in the neck, and forms a hard swelling at the side of the neck which gradually invades the surrounding tissues and becomes fixed.

The diagnosis may only be made by removing a fragment for microscopical examination. Unless the growth is small it should not be removed. X-ray therapy is useful here also.

Secondary Carcinomata of the Neck.—This is one of the commonest tumours in the neck and may be the first sign of malignancy in the oesophagus or pharynx. Malignant lymphatic glands form hard tumours which are not painful on palpation but gradually grow and invade the structures of the neck and become fixed by adhering to the fascial planes which are attached to the vertebral column. As the tumours grow they cause pressure upon the nerves, giving rise to

around the neck and yet there may not be a general deposit over the body. The treatment is excision of the main mass of the lipoma.

Encapsuled lipomata also occur in the subcutaneous tissue. They form localised rounded swellings under the skin, but attached to it, which have a deceptive feeling of fluctuation. They are very simply removed.

Subfascial lipomata of the neck occur particularly in the supraclavicular region, where they form soft tumours giving a fluctuating sensation on palpation. They are not adherent to the skin as they are under the deep fascia. In removing such lipomata care must be taken because processes grow out from the main bulk of the tumour between the important structures of the neck. The separation of such processes, however, is usually quite simple if care is taken.

Blood Cysts of the neck are very rare tumours, which are found usually in young people though they are occasionally seen in adults. They are situated above the clavicle and form compressible, soft tumours of the neck which may double their size when the patient coughs. Their dull-bluish colour can be seen through the overlying skin.

They should be excised. Usually there is a communication with the external jugular vein, but cases have been recorded where the communication was with the internal jugular. This communication is simply ligated when the tumour is removed.

Mixed Tumours of the Submaxillary Gland.—These are really adenomata of the submaxillary gland, similar in nature to tumours found in the parotid. They have a long history, are rounded, smooth on the surface, and freely movable. They sometimes grow to a very large size.



Boy holding his nose and blowing out an aerocele in his neck.

In the case of the submaxillary gland it is usually simpler to excise the gland itself, containing the tumour, rather than to confine the operation to the removal of the actual growth.

Occasionally they may become malignant, when, curiously enough, they change into squamous-celled carcinomata (see also page 250).

Aeroceles of the neck are very rare swellings found above the clavicle, which are due to a rupture of Sibson's fascia, which allows a hernia of the apex of the lung to take

CHAPTER XXIII

DISEASES OF THE CHEST

Traumatic Asphyxia

This is a condition which arises as the result of violent compression of the chest, or sometimes of the abdomen. The compression must be short-lived and soon released. Immediately, there appears a discoloration of the face and neck down to approximately the level of the clavicles. There are subconjunctival haemorrhages and bluish-red discoloration of the skin, which is due to engorgement of dilated capillaries. Scattered over this area are deeper points of petechial haemorrhages. The colour sometimes has a violet tinge and may be almost black. It soon begins to pass off and has disappeared in about 2 weeks. It is not due to haemorrhages under the skin but, apparently, to a paralytic dilatation of all the capillaries. There may, however, be some bleeding from the nose or mouth or ears, just as there is haemorrhage under the conjunctivae. Perhaps there is haemoptysis from compression of the lungs. Death may occur from associated injuries.

Why the discoloration is limited to the area drained by the superior vena cava is not definitely known, but it is said that it is because the valves of the superior vena cava and its tributaries are less developed than those of the legs, and the sudden distension due to pressure causes them to become incompetent and allows the blood to be forced back into the capillary bed, so leading to the paralysing distension of the capillaries.

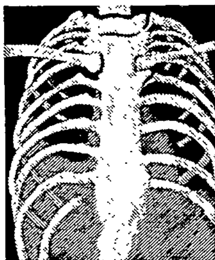
Empyema

Acute empyema is a purulent infection of the pleural cavity. The vast majority of empyemata follow some infection of the lung: pneumonia, abscess, gangrene of the lung or tuberculosis. But empyemata may arise as an extension from other regions; thus a subphrenic abscess may spread through the diaphragm and lead to this condition, as may also a liver abscess. Some empyemata are due

considerable pain. They ultimately reach the surface and ulcerate, when death may be caused by secondary haemorrhage from the great vessels of the neck. When the primary growth is in the pharynx or larynx the malignant glands are situated in the upper part of the neck. Enlargement of the supraclavicular glands on the left side may be a sign of advanced carcinoma of the stomach. Rarely glands above the clavicle are enlarged secondarily to a hypernephroma of the kidney which has been quite unnoticed.

The physical signs of an empyema are those of pleuritic effusion: dulness on percussion, loss of breath sounds, and, in children with a small effusion in which the alveoli only are collapsed, bronchial breathing. There is also loss of vocal fremitus. The apex-beat and the cardiac dulness are displaced to one or other side. Where the effusion is great the corresponding side of the thorax moves less than the normal side, because intercostal spaces are already as wide as they possibly can be. They sometimes actually bulge.

The beginning of an empyema is sometimes ushered in by a rigor, and a high temperature. The fever is intermittent in type. There is usually an accompanying cough and a very high leucocytosis, up to 40,000. If the empyema remains for a considerable time the fingers become clubbed. The infection may spread to the pericardium, the endocardium or even the peritoneum. Occasionally an empyema will point through the chest wall, in which case an abscess appears, usually in front, under the pectoralis major. An empyema may also burst into a bronchus and the pus be coughed up. X-rays are of great help in diagnosis because they reveal a fluid level with a concave upper border together with immobilisation of the corresponding side of the diaphragm.


Pleural effusion on right side.

The diagnosis of empyema is usually simple when the possibility of its existence has been recognised. Difficulties occur when the pus is situated between the lobes of the lung. Here the X-rays will be most useful in diagnosis. An interlobar empyema resembles very much an abscess of the lung, and, indeed, is dealt with in the same way.

In the treatment of empyema it is not always wise to operate as soon as the condition has been diagnosed. If the chest is opened whilst the pneumonia is at its height and when the collection of pus in the pleural cavity has not become localised by adhesions between the lung and the thoracic wall, the result is usually fatal. This is due to two factors. First, the embarrassment of the circulation, due to the sudden collapse of the lung and displacement of the mediastinum; and secondly, to the flooding of the circulation with the toxins which occur with this sudden compression of inflamed lung tissue. Under these circumstances, the best treatment is partial withdrawal of the purulent fluid by aspiration, a process which will very likely have to

to metastatic infections of the lung in septic infections such as osteomyelitis. Empyema may also result from injuries to the chest, penetrating wounds of the pleural cavity, or wounds of the lung which have given rise to a haemothorax which has become infected. The organisms commonly found are the pneumococcus, the staphylococcus, the streptococcus, the influenza bacillus, the colon bacillus or the tubercle bacillus. The pneumococcus very frequently dies out, so it is not always found in the exudation. The same is true of the tubercle bacillus. However, a primarily pneumococcal infection may be complicated by a secondary infection with streptococci or staphylococci.

When there is a large effusion into the pleural cavity, certain mechanical disabilities occur. With excessive fluid in the right side of the chest the corresponding lung collapses, the mediastinum with the heart is pushed over towards the left side. This distortion narrows the inferior vena cava where it passes through the diaphragm, and, at the same time, if the tension in the pleural cavity is great, the superior vena cava is compressed, as also is the right auricle and, to some extent, the right ventricle. Thus, the entrance of blood into the heart is impeded and so the circulation through the lungs is slowed. When the effusion is in the left side of the chest the mediastinum is pushed over to the right side and the heart is rotated so that the apex points forwards. This rotation of the heart obstructs the great vessels at its base, so that, again, there is dangerous interference with the circulation. The vessels of the collapsed lung are compressed, and some of them become obliterated, a further impediment to the pulmonary circulation. At the same time that these mechanical effects are occurring there is serious toxaemia from the absorption of the very abundant effusion.

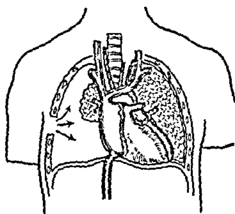
The fluid, which at first is serous, only later becoming purulent, is situated usually at the base of the lung, but it is fairly common for a part of the pleural cavity to be shut off by fibrinous adhesions before much effusion of fluid takes place, so that the empyema, instead of being general, is localised. This may be at the apex or at the base of the lung, on the mediastinal surface or between the lobes of the lung (interlobar empyema). Empyema occurring during acute pneumonia (parapneumonic empyema) is a very serious and fatal disease, because of the enormous area for absorption of toxins at a time when the immunity of the patient is low. Very often the empyema develops only gradually after the worst stage of the pneumonia has passed (metapneumonic empyema) and only becomes evident because of the failure of the temperature and general signs of illness to subside.

procedure being of such short duration that very little anaesthetic is needed. Either ether or pentothal can be administered. Some surgeons insist that the patient should lie more or less on the diseased side to allow free respiration in the opposite lung. This makes access very difficult for the surgeon and is not necessary when the operation is performed at the correct time, that is when adhesions between the lung and the chest wall have formed. The best position is with the patient propped up in a semi-sitting position and inclined towards the sound side. When the pus has been evacuated a simple drainage tube may be sewn into the wound and a dressing applied, though many surgeons prefer to have a long drainage tube dipping into an antiseptic solution in a receptacle on the floor. The object of this is to take advantage of the valvular action so that pus can be expelled but air cannot enter to take its place. Expansion of the lung is said to be encouraged by this simple device. On the other hand, there is no doubt that a long drainage tube offers some resistance to the free exit of the pus. If the drainage tube is short and a simple dressing applied, the discharge soon wets the gauze which becomes closely applied to its mouth and, impervious to air in its sodden state, itself acts as a kind of valve, being blown away from the wound when the patient coughs to allow exit of the pus and being sucked closely against it when the patient inspires. There does not seem to be any difference in the time of re-expansion of the lung whether the simple short tube is used or the long tube with some valvular arrangement. Within the empyema cavity there often exist masses of fibrin. This fibrin can be caused to disintegrate by irrigating the cavity with sodium hypochlorite solution (Milton 1 in 5). As a rule, the empyema cavity will be obliterated in 6 to 8 weeks.

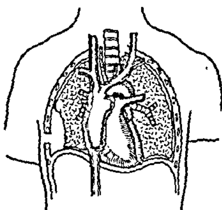
Tuberculous empyemata should never be opened unless secondary infection occurs. Aspiration is all that should be done. The treatment of an interlobar empyema is the same as the treatment of an abscess of the lung. The diagnosis will usually have been made by X-rays. It is not always wise to search for an interlobar empyema by an exploring needle, because unless the lung is adherent over the site of the puncture the infection may be conveyed to the general pleural cavity.

A chronic sinus sometimes persists after an operation for an empyema. It may be due to several causes. If the operation is carried out at too early a stage the lung may have shrunk around the hilum and become fixed in this position and unable to expand and obliterate the huge cavity. If the drainage is imperfect, pus may be locked up in a side cavity and again the sinus persist. Or the sinus may not go down further than to a piece of necrotic rib in the thoracic

be repeated. The thin purulent fluid will become thick pus as time passes and the empyema will become localised by the lung becoming adherent to the parietal pleura round the periphery of the collection of exudate. When this has happened there is not the danger of

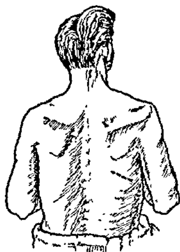


The effect of opening an empyema when the lung is not adherent to the chest wall. Note the displacement of the heart and the kinking of the venae cavae.



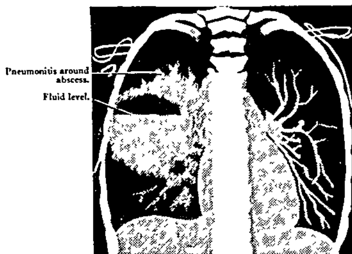
When the lung is adherent the mediastinum is not pushed over.

lung collapse if the cavity is opened and the pus evacuated. Therefore, it is a rule never to operate during the acute stage of pneumonia, nor unless the contents of the empyema are thick pus. In children in whom empyemata due to the pneumococcus are common, repeated aspiration will often cure the patient without any further surgical treatment becoming necessary. When the empyema has become localised and when the pus reaccumulates after aspiration, free drainage is indicated. The opening into the cavity is made either between two ribs through an intercostal space, or through the periosteum on the deep surface of the rib after resection of about 2 inches. In the ordinarily situated empyema the best situation to make the opening is usually in the posterior axillary line at the level of the eighth or ninth rib, but it should always be made over the dull area, where the exploring needle has proved pus to be present. If necessity arises, the opening may have to be made in the front of the chest or closer to the spine. The operation can quite easily be performed under local anaesthesia by abolishing the conduction in two intercostal nerves at the angle of the ribs and infiltrating skin at the operation site. But a general anaesthetic can usually be given without risk, the whole



Site of election for resection of rib for empyema.

occur after abdominal operations when, presumably, the inhibition of coughing allows aspirated mucus to remain lodged in the lung. Embolic abscesses occur in association with such conditions as osteomyelitis and puerperal infection. Abscesses are often classified as peripheral and hilar, but nearly all abscesses appear to be in the periphery of the affected lobe beginning at or beyond the terminal bronchioles. The so-called hilar abscesses are abscesses in the part of the lung near the mediastinum or an interlobar fissure. The pathological lesion is therefore a spherical area of inflammation near the pleural surface which breaks down in about a week to form a



Abscess of lung.

definite cavity containing foul pus, detritus and fragments of gangrenous lung. Surrounding the abscess there soon forms a layer of fibrous tissue which is of great surgical importance as it forms an avascular area which may be safely incised to reach the pus. Opening into the walls of the cavity are one or more bronchi. The abscess may discharge spontaneously into a large bronchus or into the pleural space.

Symptoms.—The disease begins with a temperature, possibly with a rigor. Pain occurs if the abscess is near the pleural surface to cause inflammation. Cough is at first dry. Later the pus becomes very foul and abundant, and changes of posture precipitate its expulsion. The presence of fusiform bacilli and spirilla in the pus is diagnostic. When they are absent and only pneumococci, streptococci or staphylococci are found, the pus is not foul. The physical signs are impaired movement, dulness on percussion, bronchial breathing, râles. Clubbing of the fingers is sometimes seen, particularly when the abscess is near the hilum of the lung.

Typically with the X-rays, a circular shadow with a fluid level is seen. It is important to have a lateral view. If lipiodol be injected

wall itself. When such sinuses persist, the underlying condition present can be very often revealed by injection of the cavity with lipiodol. This will show the track of the sinus and the extent of unobliterated pleural cavity. The problem of a sinus due to a carious rib is a very simple one. The wound must be opened up and the dead portion of bone removed, but the problem of obliterating a large cavity which has been present for months or perhaps a year is very difficult. Such chronic empyema cavities become lined by very dense thickened pleural membrane, both on the inner side of the chest wall and covering the lung. There are two methods by which the cavity may be induced to heal. In the first, the lung is freed from its imprisonment by its thickened visceral pleura, and in the second, the lung is left unexpanded but the chest wall mobilised, so that it will fall in and make contact with it. The first operation is called decortication of the lung. It is carried out by making a long intercostal incision, separating the ribs, incising the thick parietal pleura, just where it is reflected on to the surface of the unexpanded lung, and then peeling the visceral pleura from this point off the lung tissue. A certain amount of haemorrhage may occur. Rather surprisingly, however, a satisfactory line of separation may be found if the condition has not lasted too long. The thoracic wound is then partially closed, leaving in a drainage tube. Many empyema cavities have been closed by allowing the lung freedom of expansion in this way. In the second method of treatment a large musculocutaneous flap is reflected from the ribs over the whole extent of the cavity and portions of these ribs removed, so that the soft tissues may be allowed to fall in and make contact with the lung. This will not take place unless the rigid parietal pleura is also removed. Operations for chronically persisting cavities are always serious. They are associated with considerable shock, perhaps with haemorrhage, and are likely to set up severe sepsis. Patients with such cavities are always in poor health from the long-continued septic absorption. Indeed some of them eventually suffer from amyloid disease. There is also a distinct danger of a metastatic abscess forming in the brain.

Abscess of the Lung

Abscess of the lung may be the direct outcome of an intense pneumonia, complicate a chest injury, follow aspiration of septic material or a foreign body into the bronchi, or be due to an embolus from a distant focus in the body. Aspiration abscesses are particularly likely to follow operations upon the upper respiratory tract such as tonsillectomy, mouth operations or dental extractions, but they also

sometimes follows a severe injury to the lung, particularly if there is foreign body present. It may be due to the aspiration of a foreig body or piece of necrotic tumour into the bronchial tree, or the i vasion of the lung by a growth of the oesophagus, or even the pe foration of a subphrenic abscess through the diaphragm into tl lung. The gangrenous area may be localised, or diffuse areas of tl lung may die. If the process spreads to the surface of the lung pyopneumothorax results. All the pyogenic organisms are foun Very often there are also spirochaetes.

The symptoms of gangrene of the lung are very similar to tho due to an abscess, but they are more intense. Just as in the case an abscess of the lung, fever may be absent. The sputum is excee ingly foul and may contain pieces of necrotic tissue and elastic fibre Metastatic abscesses in the brain rather frequently occur. There m be glycosuria.

If the gangrenous area is localised the case should be treated as abscess of the lung and freely drained by open operation.

Bronchiectasis

Bronchiectasis is an enlargement of the bronchi which becon dilated into a series of cysts within the lung. Stagnation of tl secretions in these cysts occurs and infection is very likely to follo It is persistent because of the absence of proper drainage. bronchiectasis is said to be primary when it depends on a disease the bronchi. The walls of the bronchi, for instance, may becon inflamed and weak from a pneumonic process spreading to ther or a foreign body lodging in a bronchus may lead to dilatation the bronchi behind. The bronchi become inflamed and ulcerate Frequently the condition leads to haemoptysis. The infection sprea from the bronchial wall to the surrounding lung tissue. Seconda bronchiectasis is due to chronic inflammatory changes taking pla in the pleura and interstitial tissue of the lung, by which the walls the bronchi are pulled upon so that irregular cavities are forme This condition almost always affects more than one lobe of the lun Occasionally, bronchiectasis is due to a severe injury. This trauma bronchiectasis follows a crushing injury of the chest in which one the main bronchi becomes torn. Scarring of the bronchus leads to stricture with resulting dilatation in the periphery of the bronchial tre

There is also a congenital variety of bronchiectasis whic curiously enough, affects more often than elsewhere the left lower lob In this condition there are no chronic inflammatory changes to found around the bronchi. The dilatation is due to defects in tl

into the bronchi and an X-ray taken, it is seen to be all round the circular area but not within it, the openings of the bronchi being closed by inflammatory oedema. Bronchoscopy is useful because it may reveal a foreign body or a bronchial carcinoma as the cause. Spread of the infection to the rest of the lung, secondary haemorrhage from the walls of the cavity, or brain abscess, are complications which are usually fatal.

Treatment.—It is usually recommended that medical treatment should be employed at first for a number of weeks. This is because some lung abscesses heal up of themselves. An essential part of such treatment is that the patient should assume, several times a day, a position which will make the abscess drain by gravity (postural treatment). According to its situation this may be sitting up, on his side, on his back with his feet raised or prone over a bolster. He may have to hang over the side of the bed with one arm resting on the floor. Such an expedient often gives relief, and it is claimed that it does so more often when the abscess is situated deeply in the chest.

Although suction through a bronchoscope has been tried it has not met with much success. The best surgical treatment is incision and drainage like that of any other abscess. The lesion should be accurately localised with the X-rays and portions of three ribs, with the intercostal muscles, vessels and nerves excised over the exact site. More often than not the pleura will be adherent to the lung and there will be no danger of infecting the pleural cavity. In this case, after proving the presence of pus with an aspirating needle, the lung is incised, preferably with the cautery, until the abscess cavity is penetrated. A wide opening is made and the cavity cleared of sloughs. The wound is packed round a tube with vaselined gauze.

If, when the pleura is exposed, the lung can be seen moving beneath it, adhesions must be induced to form. For this purpose a piece of gauze soaked in tincture of iodine is laid in contact with the outer surface of the parietal pleura and the soft parts sewn over it. In 10 days' time adhesions will have formed. The wound is again opened and the lung now safely incised.

Sometimes, instead of iodine gauze, a mass of paraffin wax is moulded to the outer surface of the pleura. This will also cause adhesions, and it has been known to cause spontaneous evacuation of the pus into the wound.

Gangrene of the Lung

This may follow an attack of pneumonia, especially in people who are much depressed in health, such as diabetics or drunkards. It

sometimes follows a severe injury to the lung, particularly if there is a foreign body present. It may be due to the aspiration of a foreign body or piece of necrotic tumour into the bronchial tree, or the invasion of the lung by a growth of the oesophagus, or even the perforation of a subphrenic abscess through the diaphragm into the lung. The gangrenous area may be localised, or diffuse areas of the lung may die. If the process spreads to the surface of the lung a pyopneumothorax results. All the pyogenic organisms are found. Very often there are also spirochaetes.

The symptoms of gangrene of the lung are very similar to those due to an abscess, but they are more intense. Just as in the case of an abscess of the lung, fever may be absent. The sputum is exceedingly foul and may contain pieces of necrotic tissue and elastic fibres. Metastatic abscesses in the brain rather frequently occur. There may be glycosuria.

If the gangrenous area is localised the case should be treated as an abscess of the lung and freely drained by open operation.

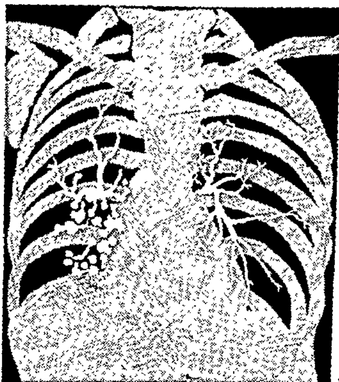
Bronchiectasis

Bronchiectasis is an enlargement of the bronchi which become dilated into a series of cysts within the lung. Stagnation of the secretions in these cysts occurs and infection is very likely to follow. It is persistent because of the absence of proper drainage. A bronchiectasis is said to be primary when it depends on a disease of the bronchi. The walls of the bronchi, for instance, may become inflamed and weak from a pneumonic process spreading to them; or a foreign body lodging in a bronchus may lead to dilatation of the bronchi behind. The bronchi become inflamed and ulcerated. Frequently the condition leads to haemoptysis. The infection spreads from the bronchial wall to the surrounding lung tissue. Secondary bronchiectasis is due to chronic inflammatory changes taking place in the pleura and interstitial tissue of the lung, by which the walls of the bronchi are pulled upon so that irregular cavities are formed. This condition almost always affects more than one lobe of the lung. Occasionally, bronchiectasis is due to a severe injury. This traumatic bronchiectasis follows a crushing injury of the chest in which one of the main bronchi becomes torn. Scarring of the bronchus leads to its stricture with resulting dilatation in the periphery of the bronchial tree.

There is also a congenital variety of bronchiectasis which, curiously enough, affects more often than elsewhere the left lower lobe. In this condition there are no chronic inflammatory changes to be found around the bronchi. The dilatation is due to defects in the

architecture of the bronchial wall. Perhaps there are no mucous glands; or cartilaginous plates may be wanting. The epithelium is cylindrical or ciliated.

The symptoms of bronchiectasis are well known. If it is congenital in type there is always a history of attacks of bronchitis from early childhood. In other cases there has usually been an attack of pneumonia, or rarely there has been a severe injury of the chest, the known swallowing of a foreign body, or the possibility of this having been done, perhaps during anaesthesia. There are cough,



Bronchiectasis. Skiagram after injection of lipiodol.

expectoration, haemoptysis, dyspnoea and cyanosis. Owing to septic absorption, the sputum being particularly foul, the patients suffer from headache, languor and loss of appetite. Children sometimes have gastro-enteritis from the swallowing of the discharge. Long-continued bronchiectasis will give rise to albuminuria and eventually to amyloid disease. The temperature varies and there are liable to be exacerbations of fever. Metastatic septic lesions may occur in distant parts of the body, such as the joints. Like gangrene and abscess of the lung, the association with brain abscesses is rather common. Owing to the contraction of the lung the heart is perhaps displaced towards the affected side. The fingers are often clubbed, but, curiously enough, this sign is apt to fail in the congenital form of bronchiectasis. Any patient with bronchiectasis is liable to attacks

of pneumonia which may go on to gangrene. The diagnosis is completed by radiography after the injection of lipiodol into the bronchial tree. This can be done in one of two ways, either by dropping the lipiodol through the aperture of the larynx after the application of cocaine, or by puncturing the cricothyroid membrane with a needle and injecting it directly into the trachea. By altering the position of the patient's chest the lipiodol may be made to run into either main bronchus at will.

In the treatment of bronchiectasis sometimes surgery is advisable. The disease is so serious and the outlook for the patient so poor ultimately, that it is worth while carrying out operative treatment although the mortality risk may be great. For early cases after an attack of pneumonia it may be sufficient to remove portions of ribs and the intercostal muscles over the lower lobe in order to allow the lung to collapse. If an abscess should form as the result of bronchiectasis, it must be treated as an ordinary abscess of the lung. After it has been drained a bronchial fistula will usually remain for which a plastic operation will prove necessary. Congenital bronchiectasis is sometimes treated by removing the affected part of the lung. Fortunately it frequently happens that only the lower lobe is involved, for it is this part of the lung that it is possible to remove with a considerable but not too great risk. Lobectomy should always be considered in children with congenital bronchiectasis because, otherwise, the prognosis is poor. In removing a bronchiectatic lobe the chest is opened by a long incision through an intercostal space, usually the seventh. The lung is separated from its surroundings, if adhesions are present, and the pulmonary ligament divided up to the hilum of the lung. A special tourniquet is then placed round the root of the lobe to be removed and the lobe cut away, leaving a margin of lung tissue for suture. The mucosa of the large bronchi is either dissected out or destroyed by carbolic acid. The cartilage of the bronchial wall is incised so that the tube will collapse for suture. The attached portion of lung is sewn tightly over the severed structures by which the bronchus is securely closed and haemostasis effected. The chest cavity is then closed, a drainage tube placed in a lower intercostal space connected with a long tube which dips under water, and the air aspirated from the pleural cavity.

The dangers of lobectomy are due to shock, but particularly to sepsis. Great care must be taken in packing off the pleural cavity and tissues of the chest wall to protect them from infection when the lobe is being removed. There is also a very distinct danger of infective invasion of the other lung if the patient be placed in such a position that dragging on the diseased lobe will cause the putrid secretions to

flow out into the opposite side. For this reason the patient is best operated upon in a sitting position. An empyema or a bronchial fistula may follow the operation, but these complications can usually be treated with success.

Tuberculosis

Surgery is sometimes employed in the treatment of pulmonary phthisis. The object of such treatment is to alter conditions in such a way that the affected lung is put out of action, and that cavities are allowed to collapse so that their walls may adhere and heal. Every operation devised for the treatment of tuberculosis has been directed towards effecting this collapse. The following procedures have been employed:

1. The Production of a Pneumothorax.
2. Paralysis of the Diaphragm.
3. Thoracoplasty.

Artificial Pneumothorax.—This is carried out by introducing a needle through the thoracic wall until its point lies in the pleural cavity, after which air is introduced. The indications for pneumothorax are not very precise. To say that it should be only employed when the disease is unilateral is incorrect, as phthisis is very seldom unilateral. It should only be used in chronic cases, of the fibroid or productive type. It should never be used in a limited early case because the prognosis without operation is so good. Neither should it be used when the disease is progressing rather rapidly. A healed focus on one side is no contra-indication to the production of a pneumothorax on the other. There must be an absence of pleural adhesions, obviously, but this cannot be determined until an attempt is made to bring about a pneumothorax. There are certain risks in carrying out the operation. The pleura must be carefully anaesthetised to avoid pleural shock, which sometimes leads to collapse of the patient, and great care must be taken that the needle does not penetrate the lung. This is determined by watching the pressure changes with respiration in a manometer. There should be a negative pressure in the pleural cavity of -2 to -8 mm. of mercury. The amount of air which is introduced should be about 300 or 400 c.c. This is gradually absorbed, so the loss must regularly be made good. The pneumothorax should be maintained for at least two years. If the cavity is large it may have to be kept up permanently. It must not be forgotten that the collapse of one lung may throw such a strain on the opposite side of the chest that a latent focus here may be lighted up into activity. Another difficulty about pneumothorax is the

presence of adhesions. The lung is most likely to be fixed to the parietal pleura just in that region which it is required to compress. All the healthy lung will then shrink and the cavity will be maintained patent by the adhesions. Sometimes these adhesions are divided surgically to allow the lung to retract. This is a delicate procedure which is carried out by the introduction of an electrically illuminated telescope through an intercostal space, by which a good view of the adhesion can be obtained (thoracoscopy). The position of introduction of the thoracoscope can often be determined by a preliminary X-ray, which will often reveal the adhesion stretched across the air contained in the pleural space. Through another aperture in the chest a cautery is introduced. Under direct vision the adhesion can then be divided. It is only possible to divide thin adhesions in this manner, and there are two risks associated with the procedure. The lung tissue may be stretched out so much that the division may inadvertently pass through the lung tissue and a large haemorrhage may result. Therefore, the adhesions should be cut off as close to the parietal pleura as possible. The second risk is that of empyema due to the setting free of organisms from the lung into the pleural space. By X-rays it can be shown that cavities in the apex of the lung do collapse after the production of a pneumothorax. It is difficult to evaluate this method of treatment, but, undoubtedly, some cases of phthisis do improve after a pneumothorax has been established. When it is thought that cicatrisation of the cavity has taken place the lung may be allowed to expand. It will do this even after the collapse has been maintained for several years.

When it is impossible to carry out a pneumothorax because of the presence of adhesions, the operation of thoracoplasty is sometimes indicated. It is a serious operation. It should not be done in the predominantly exudative type of disease, nor after a recent flare-up, nor if the pulse is over 110. The patient should have a vital capacity of at least 2000 c.c. The object is to mobilise the thoracic wall so that it will fall in upon the lung and allow cavities to collapse. The whole of the first rib is removed, nearly all the second and gradually lessening lengths of the third to the seventh. Thoracoplasty leads to permanent compression of the lung and obliteration of cavities. It is too severe an operation to be carried out in one stage. It should be begun by dividing the lower ribs, because, if the upper ribs are divided first, the compression of the tuberculous cavities at the apex may force secretions down into the lower bronchi and give rise to pneumonia of the lower lobe.

The *apicolysis of Semb* is gaining in popularity because it is very effective in getting the lung to collapse. He makes an incision

flow out into the opposite side. For this reason the patient is best operated upon in a sitting position. An empyema or a bronchial fistula may follow the operation, but these complications can usually be treated with success.

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paralysis of the diaphragm, or the growth may spread into the mediastinum and even obstruct the oesophagus. In the same way the large veins in the thorax may be compressed, leading to oedema of the face. Metastases may occur almost anywhere. They are sometimes found in bones at a great distance from the primary growth. The tumour can usually be seen by X-ray. Bronchoscopy should always be carried out in order to establish the diagnosis. It is not always possible to differentiate through the bronchoscope a malignant growth from a mass of granulation tissue, and it is often necessary to remove a portion for microscopic examination. Owing to the situation of the growth near the hilum of the lung the operative removal is often an insoluble problem. However, a few cases of complete removal of the lung have been carried out with success. X-radiation seems to favour the spread of the growth after a very temporary improvement.

Injuries to the Lung

As the result of crushes of the thorax contusions of the lung may occur. This leads to infiltration of the lung tissue with blood. The area so affected is likely to be invaded by pyogenic organisms, so that the result may be an abscess or gangrene. If the injury is near the surface of the lung an empyema may be produced. Sometimes the lung is ruptured, in which case blood is poured out into the pleural cavity into which air also escapes (haemopneumothorax). The lung is more commonly injured by the ragged extremity of a fractured rib. In this case there may in addition be subcutaneous emphysema. A stab or gunshot wound of the lung leads to haemoptysis and pneumothorax, which is very likely to be a haemopneumothorax and may be followed by septic complications. If the vessels wounded are not too large, the retraction of the lung, combined with the fact that the arterial pressure in the lungs is only one-third that of the systemic circulation, allows of the haemorrhage coming to a spontaneous end.

Symptoms.—There is always severe shock with a lung injury. There is haemoptysis and usually there are signs of pneumothorax. The volume of air which escapes into the pleural cavity may be so great that the mediastinum is pushed hard towards the sound side and increasing dyspnoea results. When the pleural cavity communicates with the exterior air is sucked in and out with each breath. This causes a flapping mediastinum and great shock which, however, can be corrected by plugging the external opening and keeping the plug in position with strapping, or tightly suturing the skin. One of these

between the scapula and the spine and displaces the flat bone forwards. The whole of the first, second and third ribs are removed. The three scalene muscles are divided, together with the fibrous bands which run from the vertebrae and the transverse processes to be attached to the endothoracic fascia. Unless this step is taken the apex of the lung will not sink down in an effective manner. Usually smaller sections of the fourth and fifth ribs are also removed.

Many small cavities in the lungs may be made to collapse by the simple measure of *crushing the phrenic nerve*. Skiagraphic investigation has proved this to be true even though the cavities are situated at the apex of the lung. The importance of this observation is very great as the procedure is a minor one, and, after about a year, the paralysed side of the diaphragm begins again to contract. At this time skiagraphy often shows the cavities to have healed.

Tumours of the Lung

The only innocent tumours of the lung which are met with, which are not great rarities, are cysts. They are congenital in origin and of no importance unless they suppurate, when their treatment is that of abscess of the lung.

Malignant Tumours.—Both sarcoma and carcinoma occur in the lung, but carcinoma is very much more common. Carcinomata appear to grow from the bronchi much more often than from the lung tissue itself. They are squamous-celled carcinomata, adenocarcinomata or carcinomata containing different-shaped cells, many of which degenerate so that only their spindle-shaped nuclei remain (oat-celled carcinoma). A very common site for the growth to begin is in the main bronchus, so that these tumours are near the hilum of the lung rather than in the substance near the periphery. There is a great tendency for degeneration of the growth to take place with the formation of an abscess. Curiously enough, some carcinomata of the lung are absolutely silent. There may be no symptoms referred to the lung at all; the patient simply wastes until near his end. Even then he may succumb to a secondary growth in the brain. The earliest sign is often a cough because of the irritation of the growth projecting into the bronchus. Later, when it ulcerates, there is haemoptysis. A large loss of blood, however, is uncommon. When the growth gets large enough to block the bronchus, dyspnoea comes on. The obstructed lung is then very susceptible to infection, so that pneumonia, pleurisy and abscess are common. A completely blocked bronchus may lead to collapse of the lung with the characteristic signs. The phrenic nerve may be pressed upon, particularly on the right side, leading to

the heart may resume its beat, the patient may die. In man it is probably safe to stop the circulation through the brain for only 50 seconds. In sudden cardiac collapse of this kind massage of the heart should be performed.. This is done through the diaphragm from the abdominal cavity, should the abdomen be open, or across the pleural cavity in operations on the chest. The heart is mechanically compressed against the sternum at the rate of about twenty times per minute. There are a number of cases on record in which the heart has been induced to resume its beat. Another stimulant to the heart is the injection of 1 c.c. of 1/1000 adrenalin into the wall of the left ventricle. The puncture is made in the fourth or fifth intercostal space close to the left side of the sternum. It is very probable that the puncture itself is an important stimulant. Although patients who have collapsed in this way have often been revived by cardiac massage and artificial respiration, the respiratory centre may have been so much damaged that it is unable to resume its function, and during the few hours or days that the patient survives there may be evident other defects in the central nervous system.

Cardiac Asthma

After a coronary thrombosis a patient usually suffers from attacks of angina, which are brought on by muscular exertion. This kind of angina is very characteristic. It is dependent upon an inadequate circulation through the heart muscle, so that the organ cannot respond to any unusual call upon it. Recently attempts have been made to provide an accessory circulation for the cardiac muscle. This has been done in two ways: by opening the chest and pericardium and suturing the pectoral muscles to the ventricle wall, or, what seems to be a better procedure, by pulling the omentum up through a hole in the diaphragm and applying it to the surface of the heart. Experimentally it has been proved that a large branch of the coronary artery can be tied with impunity when an accessory circulation has been established by this omental graft. The method is still under trial, but it promises well if the proper patients are selected.

Wounds of the Heart

Sometimes blunt force in a compression injury of the thorax will cause the heart to rupture without there being an external wound. It is a fatal injury. Stab and bullet wounds of the heart are not always immediately fatal. The right ventricle is perhaps more often affected than the left. The result of a wound penetrating the ventricular

procedures should be carried out immediately as an emergency measure. With a penetrating wound there is very likely to be in addition subcutaneous emphysema. It must not be forgotten that there is frequently an abdominal injury associated with that of the lung, and it is also well to bear in mind that haemorrhage into the pleural cavity may come not only from the lung, but from a wounded intercostal or internal mammary artery.

Operative treatment for wounds of the lung is not always called for. Many patients recover if they are given morphia to quiet the circulation, and inhalations of oxygen. If there is present a tension pneumothorax this should be relieved by aspirating the air, a procedure which may have to be repeated. Blood in the pleural cavity should be aspirated in 24-48 hours and repeated if necessary every second day. If the blood be left thick layers of fibrin deposit in the visceral and parietal pleura causing, ultimately, great pleural thickening with perhaps calcification, and preventing expansion of the lung.

Provided shock has been controlled open operation is called for within 6 hours should there be a severe injury to the lung or chest wall or continued haemorrhage, particularly if a foreign body be present. Excision of the external wound is followed by a wide intercostal thoracotomy. Foreign bodies are removed unless near the hilum when sometimes it is advisable to leave them. Suture of lacerated lung or excision of the damaged area may be necessary. The pleural cavity is then freed from blood. The wound is closed, but at another site drainage through a tube, whose end dips under water, is provided for.

Hernia of the Lung is a rare abnormality which is seen as a congenital defect or the result of a penetrating injury to the chest wall. The congenital hernia is seen as a rule in front of the chest in the position of the second or third costal cartilage. It is due to a defect in these cartilages. The acquired hernia appears, of course, at the site of the injury.

Herniae of the lung require some plastic operation on the thoracic wall for their cure.

Affections of the Heart and Pericardium

Resuscitation of the Heart

Sometimes during the course of an operation there is a sudden cessation of the heart-beat. This may be a purely reflex reaction. If the circulation remains at a standstill for as long as 2 minutes, irreparable damage is done to the central nervous system. Although

contained blood. The heart will immediately begin to beat more strongly but there will be great gushes of blood from the wound in its walls. The circulation can be controlled by compressing the vessels at the root of the heart between two fingers of the left hand, leaving the index finger and thumb free to support the edges of the wound for suture. This blocking of the circulation must not be kept up for too long a period. Silk sutures on a curved needle are used to close the wound. Drainage is not usually employed but both the pericardial sac and the pleura may need aspiration after the operation. The mortality of the operation is about 60 per cent. Many missiles have been removed from the heart during the late war. Most of them were in the right ventricle. They have been removed from both auricles but never from the left ventricle, the penetration of which by a missile always seems to lead to death. After exposure of the heart, the foreign body is palpated to define its position. Two rows of three silk sutures are passed through the heart muscle on each side of the site of the proposed incision. The assistant holds these up while the heart is incised. By crossing them he can control the loss of blood from the heart. The surgeon rapidly removes the missile with a pair of forceps, and ties one set of sutures whilst the assistant controls the haemorrhage with the other set. In skilled hands, the operation has had a very low mortality.

Pericarditis

This affection is seen in septic conditions such as septicaemia, scarlet fever, osteomyelitis and erysipelas. Owing to the severity of the symptoms of the other disease it is often overlooked. There are praecordial pain, perhaps some tenderness in this area, irregular cardiac action, dyspnoea, sometimes even dysphagia, and perhaps hiccough from pressure on the phrenic nerve. At first there are friction sounds which, however, disappear if the effusion becomes abundant, a change which is accompanied by increased praecordial dulness. Should the tension in the pericardial sac rise, there will be the symptoms of heart compression described under wounds of this organ.

The usual treatment is aspiration of the pericardial sac in the angle between the xiphoid cartilage and the seventh left costal cartilage. If there should be pus present, and drainage should be necessary, it is best to remove the seventh costal cartilage and the xiphoid cartilage and open the pericardium by this same route.

Chronic Adhesive Pericarditis.—In this condition there are numerous adhesions between the heart and pericardial wall, so that the space

cavity is the outflow of blood into the pericardial sac. The capacity of the pericardial sac is about 200 c.c. when fully distended. The continued outpouring of blood leads to the condition known as heart compression. The ventricles are unable to dilate because of the fluid in the pericardial sac, so that the whole of the venous system becomes engorged. This is seen in the veins of the trunk, the face, the upper extremity, particularly, and also in the liver. The arterial pulse becomes small, rapid and irregular, dyspnoea results and finally collapse after great distress. There are severe praecordial pain, increased pericardial dulness and, if the wound has passed through the pleural cavity, usually signs of pneumothorax. Harsh murmurs are heard on listening over the heart area. If an incision is made in the pericardium the symptoms rapidly disappear. It is said that spontaneous healing of wounds of the heart occurs in 10 per cent of cases. Even in those patients in whom the haemorrhage ceases and the wound closes, there is the danger of embolism from a portion of clot becoming dislodged. Later on the scar may give way to intracardiac pressure and form an aneurysm, which is likely to rupture. An earlier complication is the onset of septic pericarditis. In 80 per cent of cases there is a pneumothorax and this may lead to an empyema.

In the treatment of wounds of the heart it must be borne in mind that a certain percentage of patients recover spontaneously. The positive indication for operating is the occurrence of signs of heart compression with failing circulation. A general anaesthetic should be used and positive pressure by intubation, since there is very likely to be a pneumothorax. The heart may be exposed by an extrapleural route or by going across the pleural cavity. If the extrapleural route be chosen, according to the site of the injury, the right or left third to fifth or sixth costal cartilages are divided close to the sternum and turned outwards with a flap of the overlying soft tissues hinging at their junctions with the ribs, forming thus a trap-door. The pleura is pushed away from the surface of the pericardium. Another method of exposing the heart is to split the sternum from below upwards to just below the level of the third costal cartilage, where the sternum is cut across transversely. It should never be split throughout its whole extent, as severe, possibly fatal, respiratory embarrassment will come on. The transpleural exposure of the heart is carried out by making a long intercostal incision in the fourth space on the left side with perhaps division of the costal cartilages above and below. In this case the lung is allowed to collapse to some extent and blown up by positive pressure at the end of the operation.

When the pericardium has been opened it must be cleared of its

abnormally quickly to maintain the necessary output. The lungs become congested. Both right and left ventricles are hypertrophied. Owing to the diminished outflow from the left ventricle there is a weak bodily development. A skiagram shows increase in the size of the heart and especially of the pulmonary conus. There is a murmur heard over the second left intercostal space, continuous throughout the cardiac cycle, intensified during the systole. Such people do not live to old age. Moreover, they are peculiarly susceptible to bacterial endocarditis; and the astonishing fact has been established that if, in such an event, the connection between the aorta and the pulmonary artery be broken, the disease is often cured. Hence ligature of the ductus has been recommended when the development of a child is being retarded, to avoid the complication of endocarditis or to cure it when established. The safety of the operation is such as to warrant the first and second circumstances being considered as sound indications for surgery, whilst in the last case operation is the only hope of saving the patient's life.

The left pleural cavity is opened by an incision in the second intercostal space stretching from the sternum to the anterior axillary fold. The second and third costal cartilages are divided and the ribs separated widely. Above the root of the lung, the mediastinal pleura is incised just behind the phrenic nerve. With a little dissection the ductus is exposed as a short wide vessel connecting the dilated pulmonary conus to the under surface of the arch of the aorta. The vagus crossing the aortic arch with its recurrent branch curling round the ductus is a useful landmark. Usually two silk sutures are tied round the ductus and sometimes a strip of cellophane is wrapped round it because this material causes an excessive amount of scar tissue in its neighbourhood. Great care must be taken in patients with endocarditis because the wall of the ductus may be softened from inflammation. Division between clamps and ligation has been recommended and practised as a more certain means of interruption. The ductus may be too short for this operation to be possible, and anyhow it needs special non-crushing clamps and the most skilful technique if an unwelcome haemorrhage is to be avoided.

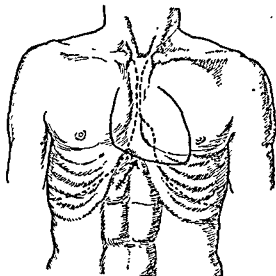
The Thymus Gland

Since myasthenia gravis has occasionally been noted in association with a tumour of the thymus gland, some connection between the two conditions was suggested. In 1936, Blalock in America cured a patient with myasthenia gravis by removing a benign adenoma of the thymus. Previous attempts elsewhere had proved fatal. From this

may be largely obliterated or the pericardium much fibrosed. It is a sequel to septic pericarditis or sometimes the result of tuberculosis.

The symptoms are those of cardiac failure because the heart can neither expand properly nor is it allowed to contract to the full extent because of its attachment to the surrounding parts. Engorgement of the veins, a large liver, perhaps ascites, and signs of renal congestion, perhaps with some hypertrophy of the heart, are seen.

Sometimes surgical relief can be given to this condition. Cardiolysis is the separation of the adhesions between the heart and the



The approach to the pericardium for aspiration of fluid.

parietal pericardial sac and the removal of the thickened constricting visceral pericardium from the surface of the ventricles. To carry out this operation the heart is exposed by an extrapleural method, the pericardium opened and the finger swept round the heart to break down the adhesions. If they are too dense for this procedure then thoracolysis may give relief. This is the removal of the third to seventh costal cartilages. The rigidity of the chest wall is thus removed so that the heart is allowed to contract.

Patent Ductus Arteriosus

Although many children with a persistent ductus arteriosus grow up into healthy adults and lead normal lives, there are others in whom surgery is called for. If the communication be a large one the output from the left ventricle is short-circuited through the pulmonary circulation. There is in fact an arteriovenous communication. The pulmonary artery becomes dilated. The pulse pressure is low. There may be some dyspnoea on exertion and the heart has to beat

CHAPTER XXIV

DISEASES OF THE BREAST

Abnormalities of the Breast

The chief abnormality is the presence of accessory breasts. These are always seen on a line running from the anterior fold of the axilla to the groin; usually just above or below the nipple of the main breast. More commonly there is an accessory nipple without breast tissue accompanying it. A more frequent variation still is an axillary lobule of the breast which is situated well outside the boundaries of the normal organ. Occasionally the breast is absent, but in this case the pectoralis major is usually wanting at the same time.

Hypertrophy of the breast is seen in young women, and very often is bilateral. The great bulk is due to the increase of the fibrous and fatty tissue between the lobules. The disease is probably due to abnormal hormonal activity, but the facts of this are not at present known. The breasts may become so large that they are an embarrassment from their weight. It may even be desirable to remove segments of them surgically in order to give relief. On the other hand, there should not be undue haste in resorting to surgery, as sometimes, for no known reason, the hypertrophy disappears spontaneously. In milder cases a support is all that is required.

Injuries of the Breast

A blow on the breast may cause a large haematoma to form in the breast which swells up and becomes much discoloured. Sometimes a blood cyst remains; suppuration may also occur. The breast should be covered with wool and supported by a bandage. A cyst will need aspiration: an abscess drainage.

Fat Necrosis

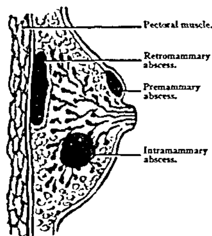
In this condition a circumscribed area of fat dies as a result of an injury, though this appears often to be slight in nature and even

arose the idea that in myasthenia gravis without tumour the gland is pouring some substance (cholinesterase) into the circulation which destroys acetylcholine, thus interfering with normal muscular action. In fact the serum of such a patient does contain a substance thus acting upon a muscle-nerve preparation. There would thus seem to be grounds for removal of the thymus in this disease. The operation has been done a number of times and with moderate success. There has been a fairly high mortality though it appears to be dropping. The patients are often very weak; they cannot breathe or cough vigorously, they may even have difficulty in eating and swallowing. It is not surprising that respiratory infections carry them off. The death rate is much greater after 40, and the chances of becoming quite normal and able to live without taking prostigmine is much greater the shorter the time the disease has lasted. About one-third of the patients are cured in this sense. A number of others have life made tolerable for them though they still have to resort to physostigmine in lesser degree.

The operation of thymectomy is done by splitting the sternum down the middle line to the level of the fourth costal cartilages and spreading the two halves apart. The gland is spread over the anterior mediastinum, often attached rather intimately to the pericardium and perhaps to the pleura. Should there be a tumour (adenoma or carcinoma) present, the difficulty of removal is greater and an area of pleura may have to be removed. The gland is in the form of two irregularly-shaped lobes with tenuous horns passing up into the neck. Its arteries are small and numerous, but usually there is one large vein draining into the left innominate. The whole gland should be removed.

the areola; it is due to infection of one of the glands of Montgomery. It is not accompanied by severe constitutional symptoms as the intramammary variety. There is only slight fever and very little pain.

A retromammary abscess is one which lies behind the breast and pushes it forwards; it is due to tuberculosis of a rib or the bursting of an empyema on the surface of the chest wall.



Abscesses of the breast.

Chronic Interstitial Mastitis.—Chronic cystic mastitis is a disease the nature of which is not certainly known. It is not a primary inflammatory condition; it is supposed that hormonal disturbance is responsible for it. The development of the breast during pregnancy undoubtedly takes place under the influence of oestrone secreted by the Graffian follicle, and of progesterone secreted by the corpus luteum. In ovariectomised rabbits oestrone causes the mammary ducts to proliferate, and progesterone to the formation and increase of the acini. In many normal women, before menstruation, the breasts swell up and become tense and turgid. What these changes are exactly is not known; probably there is not an actual epithelial hyperplasia; under the influence of the ovarian hormones there are most likely no more than a hyperaemia and an oedema; but under certain, as yet, undefined circumstances these changes go further: the epithelium of the acini and ducts begins to increase; there is a hyperplasia of the epithelium. At the end of the menstrual cycle the breast does not return absolutely to normal, so that, month by month, permanent changes become established; there is an increase in the connective tissue between the acini; there is some infiltration with lymphocytes; the epithelium forms heaped masses in the acini, sometimes almost filling them up; cysts containing a clear fluid develop, though whether they form because the epithelium blocks the ducts or because the cells divide in one plane, and so the wall of the acinus becomes of a greater area, is not known.

The disease is a very common one. It is seen in women of 30 and over. It begins usually in the upper and outer quadrant as an ill-defined swelling which is much less evident when the palmar surfaces of the fingers press it against the chest wall than when it is picked up between the fingers. The mass has a nodular feel; a cyst forms a spherical tumour which fluctuates. In time the condition

overlooked. Weeks, months or perhaps a year afterwards, a lump is found in the breast. It is really composed of autolysed fat surrounded by dense fibrous tissue. This connective tissue reaction causes the skin to be pulled upon so that a malignant growth is simulated very closely, and indeed a correct diagnosis is made only on incising the tumour; then, within the hard fibrous outer layers, will be found a soft centre of saponified fat. Local excision is all that is necessary.

Inflammations of the Breast

At birth the breasts of the infant may swell during the first few days owing to the excess of oestrone in the maternal circulation which has passed into that of the foetus. It is a condition which quickly passes. Only rarely is an infection added and an abscess forms. If it does, an incision becomes necessary.

At puberty there may occur some swelling of the breast and tenderness, both in boys and girls. No treatment is usually necessary, but the application of ung. hyd. ox. flav. and strapping the organ is recommended. Potassium iodide is also given internally.

In young male adults the breast sometimes becomes tender and swells up to form a disc beneath the nipple about 1 inch in diameter. The same treatment is carried out, care also being taken that the braces or the straps of a pack do not cause mechanical irritation. When the condition is persistent, the indurated breast should be removed.

Acute Mastitis.—Acute mastitis occurs in nursing women. Infection takes place through the ducts, and happens when there is a crack or fissure of the nipple which harbours staphylococci or streptococci. One or more segments of the breast are affected. Deep in the substance of the organ there is a very tender hard mass. The patient suffers acute pain, and has a high temperature and other signs of severe infection. An abscess is likely to form in the midst of the breast tissue.

In the early stages of acute mastitis suckling should be stopped in the affected breast; the nipple should be carefully cleaned with boracic lotion. Fomentations will often relieve the pain. Systemic penicillin may make the whole inflammatory mass shrink and go on to cure. Should fluctuation be felt or an acutely tender hard area persist without fluctuation, an incision radiating from the nipple should be made to evacuate the pus. The abscess may be loculated; it is important to drain each compartment.

Such an abscess as has been described is called an intramammary abscess. A premammary abscess is superficially situated just under

Sooner or later the malignant cells confined to the epithelium of the ducts grow out through the basement membrane into the surrounding tissue, thus giving rise to a typical carcinoma within the breast.

The treatment is a radical excision of the breast and the axillary lymphatics. If there should be any doubt about the diagnosis, a piece should be removed for examination.

Tumours of the Breast

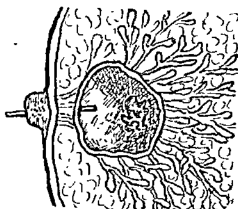
These are:

I. Innocent Tumours (1) Duct Papilloma.
(2) Fibroadenoma.
(3) Pure Adenoma.
(4) Lipoma.

II. Malignant Tumours (1) Carcinoma.
(2) Sarcoma.

Duct Papilloma

This is a papilloma which grows from the wall of one of the large ducts near the nipple, projecting into its lumen. It is not a very common disease; it is seen in women about 30 years of age. The first symptom is bleeding from the nipple; there is usually nothing else. At the beginning the papilloma is too small to be felt; but it may obstruct the duct, and then this structure dilates into a cyst which of course lies just under the areola, while the triangular sector of breast corresponding to this duct becomes indurated. Later on in the course of the disease, the tumour itself becomes palpable.



Duct papilloma of breast.

More than one of the large ducts may have papillomata within them.

The condition is very slowly progressive though it may remain apparently stationary for years. It never becomes malignant. It is always at first difficult to decide whether the patient has a duct papilloma or a duct carcinoma, as bleeding from the nipple is the first sign in both cases. If no tumour can be felt, the best way to come to a correct diagnosis is to see the patient at intervals for a few weeks;

spreads throughout the whole breast which then feels uniformly lumpy; and becomes bilateral though the left one is, as a rule, first affected. The patient complains of pain and tenderness, worse just before menstruation. Glands in the axilla are, in addition, swollen and tender also.

Though the epithelium divides and fills the acini, it seems to have very little tendency to break through the basement membrane and invade the surrounding tissue; there is no fear of cancerous degeneration.

In mild cases, treatment is scarcely necessary. Potassium iodide is sometimes given internally, and the breast is occasionally strapped, but good supports are easy to obtain nowadays, and they are as efficient, and much less unpleasant, than strapping. Operation is indicated when there is a lump the nature of which is not quite clear; it is really done to establish the diagnosis. A cyst should always be removed; it will only grow larger and perhaps suppurate; moreover, cysts of the breast sometimes have papillomata within them which may be malignant. These indications are met by a local resection of a part of the breast. Only when the whole organ is affected and the patient complains of a great deal of pain is it desirable to take away the secreting tissue in its entirety. Very often this is done through an incision below the breast, turning the organ upwards and leaving the nipple. There is not much point in doing this, for the result is frequently most unsightly.

Eczema.—Eczema of the nipple is not uncommon. It makes the surface of the nipple and areola red, scaly and weeping: it causes irritation and a burning pain. It is usually easily cured by cleaning the nipple and areola and applying an emollient ointment such as ung. calaminae or ung. zinci. It may make conditions favourable for the invasion of the ducts with staphylococci and so lead to acute mastitis and abscess.

Paget's Disease of the Nipple.—This is a disease of the nipple and areola which looks at first sight extremely like an eczema. It lasts for a very long time with little change; it does not get better and relapse under treatment as eczema does; it does not irritate and burn in the same way. It is steadily progressive in extent, and, finally, is always associated with a carcinoma deep within the breast tissue. The nature of the disease has been much discussed. It seems actually to be a carcinoma from the first, which originates in one of the ducts; from which malignant cells migrate to the epidermis, where they lie between normal epithelial cells as the so-called Paget bodies: it is in fact a carcinoma whose cells, instead of being separated by a fibrous tissue stroma, have between them the normal cells of the epidermis.

pregnant, when they suddenly begin to grow very quickly and reach large dimensions. Because of this they should be removed.

The *fibroadenomata of middle-aged women are much less* commonly seen. They are soft in consistency and often cystic. They may reach a huge size affecting the contours of the breast, and ulcerate on the surface by causing pressure necrosis of the skin. When this happens, it is recognisable by the fact that a probe can be introduced under the margin of the skin where it adjoins the ulcer. They are as easily taken away as the hard variety. Very rarely, a fibroadenoma becomes malignant after existing for a long time. It is usually stated that it changes into a sarcoma; this is so, but not invariably; the epithelial elements may take on the malignant growth and a carcinoma result.

Adenoma

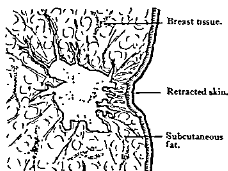
The pure adenoma of the breast is quite a rarity. It also forms a rounded tumour but it is softer than the fibroadenoma.

Lipoma

This tumour in the substance of the breast is usually easily diagnosed.

Carcinoma

Carcinoma of the breast is the commonest variety of malignant disease in women. It is mostly seen between the ages of 35 and 50 but sometimes occurs in younger adults and in women of quite advanced age. It is usually a simple carcinoma of the scirrhous type: medullary carcinoma occurs but is much less common. The growth arises from the acini or the smaller ducts. An adenocarcinoma growing from one of the larger ducts near the nipple has rather different characteristics from the ordinary form of growth; it is called a duct carcinoma.



Carcinoma of breast.

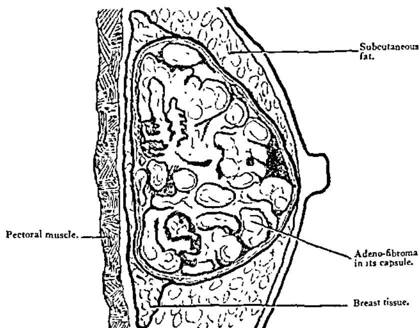
The scirrhous carcinoma at first is just a hard lump in the breast. There is no pain, and the patient becomes aware of its presence accidentally. The outlines are distinct unless the tumour is surrounded by an area of chronic mastitis when the edges may be rather difficult to define. The fibrous tissue which forms around the carcinoma

if the condition is malignant, a lump in the breast will soon be evident and operation is necessary. If a tumour is present, both conditions need operating upon.

When there is no lump to be felt in a duct papilloma, no harm will come from waiting. If operation is decided upon, the situation of the papilloma can sometimes be determined by squeezing some blood out of the nipple and then passing a piece of silkworm gut into the mouth of the bleeding duct. If it cannot be decided from what part of the breast the bleeding comes, the whole secreting tissue must, of necessity, be removed.

Fibroadenoma

This is a tumour in which the connective tissue and the epithelium both take part. It is met with in two forms: the hard fibroadenoma



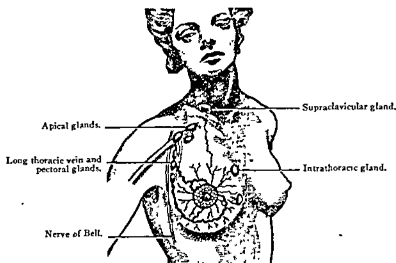
Fibroadenoma of breast.

of young people in the 20's, and the soft cystic adenoma of women in later middle life.

The hard fibroadenoma is usually of small size; it forms a spherical nodule in the breast which is very freely mobile; it slips away from the examining fingers; it is not tender and is quite unattached to the skin or deeper structures.

These fibroadenomata should be removed; they are well encapsuled and their surface, when cut across, assumes a convex contour and has a folded appearance resembling the section of a compact cabbage. They slowly increase in size but do no harm unless the patient should be

Very little of the lymph normally runs from the upper part of the breast through the fibres of the pectoralis major to the subclavian glands lying on the costo-coracoid membrane, and there is a very meagre flow through the second, third and fourth intercostal spaces into the anterior mediastinal glands. It must be emphasised that by far the greater part of the lymph from the breast goes into the axillary glands; a very small quantity elsewhere. When, however, the main trunks become blocked with carcinoma cells, the lymph is forced to travel by other routes; then the accessory paths to the subclavian and mediastinal glands become important; then also lymph will pass straight from the breast over the clavicle to the supraclavicular glands;



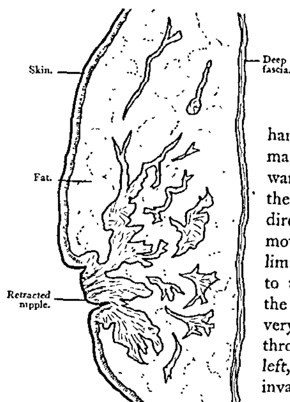
Lymphatic drainage of the breast. The subareolar plexus with its tributaries and two efferent vessels is shown.

or go across to the lymphatic territory of the other breast; or flow downwards towards the epigastric angle where it passes through the linea alba and reaches the subperitoneal tissue by which means malignant cells either enter the liver along the falciform ligament or, growing to the surface of the peritoneum, become detached and fall into Douglas's pouch. A ridge of carcinoma in this situation can sometimes be felt in advanced cases: it is called the rectal shelf. Metastases may occur in both ovaries from the implantation of such cells.

The glands, therefore, on the inner wall of the armpit and the central axillary glands should be examined for enlargement. Carcinomatous glands are hard and painless. The glands above the clavicle when affected are a sign that the disease has progressed far.

Carcinoma of the breast is peculiarly liable to spread to the bones and lungs. When the axillary glands are blocked by growth, the lymph, being forced to flow in a retrograde direction along other afferent paths, may carry carcinoma cells to the upper end of the

contracts and pulls upon the skin; so that, if the skin over the lump is gently displaced, it will be found to dimple at this point. This is a very important sign of malignancy and is found in very few other conditions and these are rare: they are the scar of an abscess, chronic fibrous tuberculosis of the breast and fat necrosis. The fibrosis also causes the nipple to be retracted and often to lie at a higher level than that on the opposite side. In a similar fashion the growth becomes adherent to the deep fascia. This can be proved by putting either the *pectoralis major* on which two-thirds of the breast lie, or the serratus magnus upon which one-third lies, into action: the former by making the patient press down with her hand upon her hip, the latter by making her push horizontally forward. In carrying out the test, the tumour should be moved in the direction of the fibres of the muscle; movement in this direction will be limited but not in that at right angles to the fibres. The consistency of the growth is not only hard, it is very hard, almost like a stone felt through the overlying tissues. If left, a carcinoma will eventually invade the skin, which first becomes reddish blue in colour and then ulcerates, the sore having a hard raised edge and a sloughing base devoid of granulations. With the permeation and blocking of the lymphatics the skin overlying the breast becomes oedematous and, the mouths of the sweat glands standing out very distinctly, the appearance resembles that of the skin of an orange or a pig. Sometimes there are outlying nodules of carcinoma in the surrounding skin.



Carcinoma of breast. Diffuse growth spreading from nipple.

Carcinoma of the breast spreads by the lymphatics and by the blood-stream. Around the acini is a network of fine lymphatic vessels from which the lymph runs along the ducts until it reaches a plexus of large lymphatics under the areola (the subareolar plexus); from this, two main trunks run to a chain of glands lying along the lateral thoracic veins on the inner wall of the axilla. From these glands the lymph goes to the central group lying on the axillary vein.

Fixation to the chest wall, retraction of the nipple, peau d'orange and hard insensitive glands in the axilla are confirmatory signs, but are present only in late cases where the prognosis is unfavourable. When the breast is extensively puckered, or the growth has broken through the skin, the nature of the condition is quite clear. The only difficulty occurs in early cases where there is nothing but a hard lump to be felt within the breast substance. In such cases an exploratory incision is necessary to ascertain its true nature. It has already been mentioned that the almost distinctive sign of a malignant growth, namely adhesion to the skin, is also sometimes seen in chronic tuberculous mastitis, fat necrosis, and with the scar of an abscess.

Treatment.—The breast is one of the regions of the body where the surgery of malignant disease meets with considerable success. This is because the cancer is on the surface of the body and is recognised at an early stage, and the anatomical arrangement makes it possible to remove the growth, the lymphatic glands that drain it, and the connecting lymphatic vessels in continuity. If a radical operation is done when there are no secondary growths in the glands in the axilla, the permanent cures reach 70 per cent; if there are already metastases in these glands, the cures amount only to 25 to 30 per cent. This difference is due to the fact that, when the path to the axillary glands is blocked by cancer cells, the lymph has to flow in other channels, thus reaching sites beyond the area of operation: places the position of which cannot be predicted, and so cannot be dealt with.

The radical operation consists in the removal of about 2 inches of skin around the site of the growth, the whole of the breast tissue, both pectoral muscles and all the glands in the axilla in continuity. The pectoralis major is taken away because some lymphatic vessels pass through it into the subclavicular glands; the pectoralis minor because this gives freer access to the apex of the axilla. The wound must always be drained because the lymphatic vessels coming up from the arm are cut across, and of course, lymph being colourless, their severed ends are not seen and ligated; a considerable quantity of clear fluid drains away for some days.

The removal of the glands above the clavicle does not make the ultimate results any better. Neither, when the growth is not adherent to the deep fascia, does removal of the pectoral muscles. Indeed in such circumstances there is a great advantage in leaving them. With good retraction the surgeon is not severely handicapped in making a clearance of the axillary glands.

Some surgeons give a course of X-rays after the operation; others think that local metastases are more likely to appear when X-rays are employed. There are no data which allow us to form a reliable

humerus. It is also said that, when the anterior mediastinal glands are blocked, the lymph flows backwards along intercostal vessels, to glands beside the spine; and so it gets into the lungs, the spine, and even, perhaps, into the upper end of the femur. Nevertheless, there is no doubt that dissemination takes place by the blood-stream, by which route the carcinoma reaches the skull bones and other parts of the skeleton, as well as the lungs and brain. Clinically metastasis in the bones gives rise to severe pain, pathological fracture, or in the spine to a sudden collapse with a paraplegia; in the brain to intense headache and signs of cerebral tumour; in the liver to a hard palpable mass; and in the lungs to cough, dyspnoea, haemoptysis and shadows in the X-ray film. An irremovable mass of glands in the axilla or root of the neck may invade the brachial plexus and cause an agonising neuritis.

The course of scirrhous breast carcinoma varies very much. Unless an operation is done, the patient does not survive much longer than two years. Yet sometimes, especially in old people, the growth may be so slow that the victim may live six or even ten years. Death takes place from metastases in the lungs, brain or liver.

In young people, though the disease is usually said to run a rapid course, this is not always the case. In fact it is impossible to foretell the future of a patient with a carcinoma of the breast with any certainty, unless of course the presence of a death-dealing metastasis is detected.

In medullary carcinoma the growth does not feel so hard, and as a rule the progress of the disease is rather rapid. In other cases a scirrhous growth may infiltrate the skin and subcutaneous tissue of the breast over a wide area, forming a hard layer; this is called cancer en cuirass. A very acute dissemination of a carcinomatous growth throughout the breast sometimes occurs, particularly if the disease develops in a woman who is pregnant. The whole organ swells, is painful and tender and has a reddened, inflamed appearance, so that the condition resembles strikingly acute mastitis (cancerous mastitis). At the other extreme, the growth may be so small that nothing is noticed amiss until perhaps a bone breaks, and even then a careful search to find it is necessary.

It has already been pointed out that duct carcinoma is a name given to a cylindrical-cell carcinoma originating in one of the larger ducts. This variety of growth is thus always situated just beneath the areola. Its chief symptom is bleeding from the nipple. It is not so malignant as the usual scirrhous form of carcinoma.

The diagnosis of cancer of the breast is usually easy. The points to rely upon are the hardness, the absence of tenderness, and the dimpling of the skin when the growth is pushed to one side.

A radical amputation of the breast including the glands in the axilla should be done.

Cysts of the Breast

A *Galactocele* is a retention cyst due to obstruction of one of the main ducts. The cyst is necessarily close to the nipple. It contains milk or cheesy material. The condition is only very seldom seen in women who have not had children. The manner of the obstruction of the duct is not known. The cyst should be removed by an incision radiating from the nipple.

A *Serous Cyst*, due to the distention of a lymphatic space, is very occasionally found.

A *Hydatid Cyst* is just as uncommon in this country.

The commonest of all cysts are those associated with chronic interstitial mastitis. They have already been considered.

Cysts are sometimes associated with *New Growths.* They occur in the soft fibroadenomata of older women, and also from the necrosis and degeneration of carcinomata. A duct papilloma by obstruction will give rise to a cyst situated beneath the areola.

Tuberculosis of the Breast

Tuberculosis of the breast is rather rare. Infection takes place through the blood-stream. An ill-defined mass forms within the gland, often in the upper and outer quadrant. After a time in its centre caseation occurs and then softening: a cold abscess. This burrows to the surface and discharges from a characteristic tuberculous sinus. The glands in the axilla are enlarged. At other times the disease is very chronic, and for long there is nothing but a hard mass of fibrous tissue in the substance of the breast. The fibrosis is so great that the skin is pulled upon and the nipple retracted. The diagnosis from a carcinoma can only be arrived at by operation. Tuberculous mastitis is never seen in children, and whilst it occurs usually about the 30's it is also met with in quite old people.

The treatment is the removal of the whole breast and the glands in the axilla. Recurrence either in the breast or in the lymphatics is frequent after a partial operation. The pectoral muscles need not be touched.

Syphilis of the Breast

The primary chancre is seen on the nipple and was common when it was customary to use wet-nurses. It may be a simple fissure or a raised papule. The glands in the axilla are enlarged but not tender.

judgement as to whether the X-rays influence favourably or not the life of the patient.

Carcinoma of the breast can also be treated by radium. Needles containing the salt are placed all round the growth in the breast, and in the axilla. Statistics show that the late results of the radium treatment are about the same as those obtained by radical operation. One objection to the radium treatment is the very severe neuritis of the brachial plexus which sometimes follows it and lasts for many months; another is the fact that a fibrous nodule is apt to remain at the site of the growth and by its mere presence gives rise to anxiety to the patient.

When local skin recurrences happen, it is often possible to remove them by operation. When this cannot be done, X-ray therapy *frequently gives great relief. Recurrence of the growth in the axilla* may give rise to intolerable pain from the invasion of the brachial plexus. Occasionally the posterior nerve roots within the spinal canal have been divided for this. It is very questionable whether a severe operation of this kind is justifiable when morphia in large doses will bring about as much relief.

Patients die from carcinoma of the breast, in extreme dyspnoea from extensive involvement of the lungs, with a large liver and the abdomen distended by ascites, with secondary tumours in the bones, in coma from a growth in the brain, or paraplegic, from invasion of the spine and cord.

Sarcoma

Sarcoma is a rare malignant tumour of the breast. It occurs in young as well as middle-aged or older women as a rounded lump which grows *rapidly*; *it is movable* and has characteristics very like those of a fibroadenoma for which it is often mistaken; it is not tender and causes no retraction or puckering of the skin. The glands in the axilla are not *affected*. It may quite quickly reach an immense size such as a fibroadenoma would only attain after many years (unless the patient happens to be pregnant). As it grows larger the skin gets reddened, engorged subcutaneous veins become prominent and ultimately the tumour breaks through to the surface, a fungating mass. An uncommon phenomenon is sarcomatous degeneration in a simple fibroadenoma.


Sarcoma of breast.

CHAPTER XXV

DISEASES OF THE OESOPHAGUS

Foreign Bodies in the Oesophagus

Numerous are the foreign bodies which have been found impacted in the oesophagus: pins, needles, coins, keys, tooth plates, children's toys, fish bones, meat bones, solid lumps of meat and many other things. The commonest site of the impaction is at the level of the upper aperture of the thorax.

The patient has the feeling of the object having become wedged in his throat. Very soon dysphagia is noticed which becomes gradually more pronounced because of the swelling of the oesophageal mucosa and muscular spasm. Pain may be severe on attempts at swallowing and the effort may cause vomiting. Above the impacted body food and saliva collect, stagnate and decompose. This septic material may gain access to the larynx and so lead to pulmonary complications. Ulceration, particularly where the edges of the object come into contact with the oesophageal wall, may afford this infected material entrance into the cellular tissues of the neck or the mediastinum. Perforation into the trachea, or even into one of the large blood-vessels, may actually take place. A pleurisy or a pericarditis may be set up. After removal, a cicatricial stricture may be a remote complication.

The most satisfactory treatment of this accident is the removal of the foreign body with the aid of the oesophagoscope. This requires a certain amount of skill and experience, for the softened oesophageal wall above the obstruction can be very easily perforated. Only very rarely, when it proves quite impossible to dislodge the object by manipulation endoscopically, is it necessary to open the oesophagus—oesophagotomy. Cervical oesophagotomy is carried out through an incision in the lower part of the left side of the neck. From here it is possible to reach 6 inches below the level of the cricoid cartilage. However carefully it is performed, the operation is liable to be followed by sepsis in the neck spreading down into the mediastinum. So fatal

In the early stage of tertiary syphilis a chronic diffuse mastitis is sometimes seen, usually in men. It disappears quickly with anti-syphilitic treatment.

Very rarely, a gumma appears in a woman's breast in the late tertiary stage. It is situated near the nipple and is a hard mass like a carcinoma; but its growth is much more rapid, and soon it gives rise to a characteristic gummatous ulcer. A history of infection or of miscarriages, or the discovery of signs of former syphilitic lesions, aid in the diagnosis. The gumma soon disappears with treatment.

This, at first, is noticed only with solids; it may be intermittent in nature, depending upon spasm of the muscle or inflammatory swelling of the mucous membrane. Gradually the difficulty increases, the patient takes to a liquid diet, until finally he finds that not even liquids will pass down without effort. There is reflexly a greatly increased secretion of saliva, in fact the salivary glands actually hypertrophy. Thus saliva continually rises in the mouth and, mixed with the decomposing secretions from the oesophagus, is exceedingly foul. The rate of bodily wasting is rapid, so that the patient loses several stones in weight in a few months. He is dehydrated. His abdomen is scaphoid and his loose skin, devoid of elasticity, lies in folds. The urine is scanty and he suffers very much from thirst. His ribs stick out prominently and his forearms look to be nothing but skin and bone. There is not usually much to be felt, though sometimes there is palpable a lump in the neck just above the sternum. Enlarged glands are also sometimes felt here. Death usually takes place from starvation, but a number of complications may occur. Fairly common is involvement of the recurrent laryngeal nerve which gives rise, first, to abductor, and finally to complete paralysis of the vocal cord of the same side. Irritation of the phrenic nerve in the thorax may cause persistent hiccough, and if the tumour grows out into the mediastinum and presses upon an intercostal nerve, the most severe pain may result. The formation of a fistulous opening into the trachea or bronchus will quickly cause a septic pneumonia and lead to death. A less common complication is ulceration into the carotid or aorta, with profuse haemorrhage from the mouth. Septic mediastinitis either by direct spread or from an infected lymphatic gland is another cause of death.



Carcinoma of the oesophagus. X-ray demonstration.

In the diagnosis the history of gradually increasing difficulty in swallowing is significant. The X-ray examination shows the holding-up of the bismuth cream, and the film the shadow of the dilated oesophageal lumen tapering to a point below. On oesophagoscopy the inflammation of the mucosa is seen, whilst it is evident that the wall

is this complication that, when the object is immovably impacted in the lower part of the oesophagus, attempts are made to remove it from below by opening the stomach rather than perform a posterior mediastinal oesophagotomy. However, with penicillin and sulphadiazine the outlook may have improved.

Tumours of the Oesophagus

Simple Tumours

These are very rare. A pedunculated tumour, a lipoma, covered with mucosa growing from the upper and anterior wall of the oesophagus is sometimes seen in elderly men. It gives rise to dysphagia. Diagnosis is made by means of the oesophagoscope. It is removed endoscopically.

Malignant Tumours

These include sarcoma and carcinoma, but the former is so rare that it is of no clinical importance.

Carcinoma of the Oesophagus

This is one of the commoner forms of cancer from which men suffer. It is rather unusual in women. It is a squamous-celled carcinoma. It is most frequent between the ages of 50 and 70. There are three sites of election for its growth; the upper and lower ends of the oesophagus and the place where the left bronchus crosses it. More cases occur in this last situation than at the extremities. The lower end of the oesophagus is sometimes affected by extension from a carcinoma of the cardiac end of the stomach. As we have seen, women are prone to suffer from a carcinoma at the lower end of the pharynx. Such a growth may extend downwards to the oesophagus.

The tumour itself takes on a polypoid form or it appears as a typical malignant ulcer. Above the growth there is hypertrophy of the oesophageal wall, some dilatation but not usually very much, and always a septic oesophagitis. Direct extension may affect the larynx, thyroid gland or great vessels in the neck, the lungs, pleura, pericardium, recurrent nerves, phrenics or aorta in the thorax. Secondarily infected lymphatic glands are found in the neck, particularly in the left supraclavicular triangle, and in the mediastinum.

The first symptoms are a sensation of uneasiness or weight behind the sternum. Then there comes on the difficulty in swallowing.

able now that some protection from sepsis can be afforded by penicillin.

Occasionally it is possible to excise a small growth of the oesophagus at the upper end from the neck and restore the continuity of the tube.

It might be expected that, being a squamous-celled carcinoma, a malignant growth of the oesophagus would be very sensitive to radium. This, however, is not the case; the action of radium is most uncertain and, on the whole, unsatisfactory. Radium can be applied by fixing the containers within an oesophageal tube so that when the tube is in place the radium is within the growth. In order to do this, not only must the position of the growth be known, but the vertical extent of the neoplasm. This can be estimated by putting the patient in the Trendelenburg position whilst he is swallowing the barium for X-ray examination. The cream will then flow upwards and indicate the lower margin of the growth. Radon seeds can sometimes be distributed through the tumour by means of the oesophagoscope. They have also been implanted outside, the growth having been exposed by the transpleural route. Radium may produce much relief of the symptoms, though the prospect of cure is very slender.

Dilatation of the stricture through the oesophagus at regular intervals may allow the patient to carry on in comfort for a considerable time. In the end it will usually lead to such injury to the oesophagus that septic infection of the mediastinum takes place.

Another palliative method which sometimes relieves for a considerable time is the intubation of the growth. Souttar's tube, made of a tightly coiled wire, with an expanded upper end to prevent the tube passing downwards and an additionally distorted contour for the same purpose, is the best. It is inserted endoscopically. As is to be expected, such a foreign body sometimes ulcerates through the wall of the oesophagus. Nevertheless the method serves a useful purpose in the treatment of some patients.

A palliative gastrostomy, an opening into the stomach through which the patient can be fed, gives, perhaps, the most relief of any method. The opening is made in a valvular manner so that undesired escape of gastric contents does not take place. The patient's nourishment is limited to liquids or such semi-solid material as will pass through the tube. After the operation has been done, the rest afforded to the oesophagus allows the inflammatory swelling to subside and in a few days the patient begins again to swallow, which he may do for a considerable time.

in the neighbourhood of the carcinoma is rigid. The growth itself appears as an ulcer with a raised margin or an irregular mass projecting into the lumen of the oesophagus which easily bleeds on touching it with the instrument. When the nature of the lesion is uncertain a piece should be removed for examination microscopically.

In the *treatment* of the disease an attempt may be made to remove the growth or to destroy it by radiation; or the patient may be abandoned to his fate, the remainder of his life being made more tolerable by feeding him through an opening made into his stomach and the exhibition of opium when the need arises.

The problem of the excision of an oesophageal growth is a very difficult and intricate one. In the first place, the middle of the oesophagus, where the majority of growths are situated, is very inaccessible. It lies practically in the centre of the thoracic cage, as far from the back as from the front. Then it lies very close to important structures: the aorta, the phrenic and vagus nerves, the azygos vein. To these it may have become adherent. There is the danger of sudden arrest of the heart in any interference with the vagus. There are the difficulties of a pneumothorax.

There is some difference of opinion as to what period of the disease metastases occur. The information about this matter is rather conflicting. Some surgeons believe that it is scarcely ever worth removing a growth when the symptoms have become pronounced enough to drive the patient to seek surgical aid, because at this period dissemination has already progressed to a stage where eradication is impossible. There are others who think that lymphatic metastasis is late and that an attempt at removal is more frequently justifiable. The technical difficulties of the operation have long been overcome. The middle of the oesophagus is best approached across the pleural cavity through an intercostal space. The mediastinal pleura is incised and the tumour laid bare. Too often at this stage it is found that the local extension prohibits excision and the operation has to be abandoned. If it proceeds the growth is isolated, the vagal reflexes being prevented by novocainisation, should the nerves need division. The diaphragm is incised from the oesophageal opening outwards. The oesophagus is divided just above the cardia and its stump invaginated into the stomach. Proceeding upwards, the oesophagus is separated from behind the aortic arch and cut across well above the growth which is then free and is removed. The stomach is mobilised by ligating and dividing the coronary artery and the vasa brevia. The fundus can then be pulled up freely into the pleural cavity to allow of the upper end of the oesophagus being implanted into it. The thorax is closed. This is a severe operation, but justifi-

able now that some protection from sepsis can be afforded by penicillin.

Occasionally it is possible to excise a small growth of the oesophagus at the upper end from the neck and restore the continuity of the tube.

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Peptic Ulcer of the Oesophagus

This is a rare lesion in the oesophagus. It is a small round ulcer found only at the lower end just above the cardiac opening, of the same nature as a simple ulcer of the stomach. It is indeed frequently associated with an ulcer in the stomach. There are indigestion and a burning pain felt behind the sternum as a rule, but sometimes the first sign is a profuse haematemesis from which the patient may die. If the ulcer heals, cicatrisation may lead to the formation of a fibrous stricture. The presence of an ulcer may be suspected from an X-ray; it is established by oesophagoscopy, though differentiation from a carcinoma may only be possible by removing a piece for microscopic examination.

The treatment is the same as the medical treatment of a gastric ulcer. If there be a gastric ulcer present, partial resection of the stomach is not only likely to cure the gastric condition but to lead to rapid healing of the oesophageal ulcer. When there are repeated haemorrhages or fibrous stricture, transthoracic removal of the lower end of the oesophagus should be considered.

Varices of the Oesophagus

Sometimes very great dilatation of the veins of the mucosa of the lower end of the oesophagus takes place. This occurs when there is cirrhosis of the liver with portal obstruction. The dilated veins are the communications between the obstructed gastric veins and those of the oesophagus which open into the azygos vein. They give rise to no symptoms until a haemorrhage occurs. This is apt to be mistaken for a gastric haemorrhage, but the diagnosis is made clear by the discovery of a large liver and, perhaps, if the patient has splenic anaemia, an enlarged spleen. The haemorrhage may be so profuse as to be fatal. Treatment can only be symptomatic. A blood transfusion may help. Though a serious haemorrhage has occurred it may still be advisable to remove the spleen in a case of splenic anaemia.

Tuberculosis of the Oesophagus

This is a rare condition which is found in patients suffering from pulmonary tuberculosis. It may be the extension of a tuberculous ulceration of the pharynx or, more often, the invasion of the tube from a disintegrating tracheo-bronchial gland. Pain and dysphagia are the usual symptoms. An irregularity will be seen on X-ray

examination but oesophagoscopy is necessary to establish the diagnosis. The local application of 20 per cent lactic acid is recommended. When the ulcer heals, the passage of bougies may be necessary to dilate a stricture. The patients are not always about to succumb to their pulmonary phthisis.

Syphilis of the Oesophagus

During the secondary stage of syphilis there may be an oesophagitis causing some dysphagia which rapidly yields to treatment. The formation of a gumma in the oesophagus is very rare. Such a lesion narrows the oesophagus, giving rise to difficulty in swallowing. An X-ray will show the encroachment on the oesophageal lumen, whilst through the oesophagoscope will be seen either a bulging of the wall with intact mucous membrane, or a gummatous ulcer. To distinguish the lesion from a carcinoma it may be necessary to remove a piece of the ulcer margin for examination. Anti-syphilitic treatment should be given and dilatation carried out should it be called for.

Simple Stricture of the Oesophagus

Cicatricial stricture of the oesophagus is nearly always the result of the swallowing of caustic or very hot liquids. Rarely it is due to the healing of a peptic ulcer or an oesophagitis associated with cardiospasm. These fibrous strictures due to the swallowing of corrosives are usually at the upper end of the oesophagus in children and at the lower end in adults. They may be bridle (involving only a part of the circumference), annular or tubular, according to the amount of damage done. The symptoms begin within a period of weeks of the patient having swallowed acid or other caustic. They are a gradually increasing dysphagia and regurgitation of food. The obstruction sometimes becomes absolutely complete so that not even saliva is able to reach the stomach.

X-ray examination is carried out by watching the patient swallow a thin barium-containing liquid on the fluorescent screen and also taking a photographic record. The dilated oesophagus above the stricture is seen and the thin streak of opaque liquid passing through the stricture. Oesophagoscopy must be carried out with care, for the upper part of the oesophagus may be much inflamed. The opening of the stricture, which is usually eccentric in position, may be difficult to see. A bougie should be passed through it to determine the degree of narrowing.

The treatment of a fibrous stricture of the oesophagus is by gradual dilatation with bougies. If there is much oesophagitis, it may not be wise to do this straightway, from fear of a possible abrasion allowing the septic process to reach the mediastinum. The patient should be kept in bed, given nourishing liquid or semi-liquid food, with frequent copious drinks of water. If the nutrition of the patient is very poor it may be advisable to feed him temporarily through a gastrostomy opening. When the inflammation in the oesophagus has subsided, the passage of bougies under direct vision is begun. No force should ever be used. A bougie of a size that is held gripped should be left in place for five minutes and no more dilatation done for a week. At the next attempt it will be found that the same-sized bougie will pass quite easily and so indeed will a bigger one. Thus the enlargement of the lumen is brought about without tearing of the oesophageal wall which would only lead to further cicatrisation. The aperture of the stricture is usually eccentric and sometimes very difficult to see. If it cannot be discovered the oesophagoscopy should be discontinued. At a later date another attempt will most likely prove successful. Or the patient may be given about six yards of silk thread to swallow overnight, one end being secured around his ear. The next morning the thread will have passed the stricture, gone through the stomach and into the duodenum. The proximal end can then be pulled tight, a bougie with a terminal eye passed over it and through the stricture. If only a fine bougie will pass, it is a good plan to leave it in position for 24 hours, when considerable relaxation of the stricture will have taken place.

Only very rarely is there necessity for a permanent gastrostomy.

Spasmodic Affections of the Oesophagus

Spasm of the oesophageal musculature occurs at two places, at the upper end where it is due to the contracture of the lowest fibres of the cricopharyngeus muscle, so that indeed it should be called pharyngeal spasm; and at the lower end where the oesophagus passes through the diaphragm. At this latter point, one or two inches above the cardiac opening into the stomach, there is a definite thickening of the muscle forming a sphincter. Physiological experiments on animals have demonstrated that stimulation of the vagus nerve causes peristalsis of the oesophagus and relaxation of the cardiac sphincter, whilst stimulation of the sympathetic nerves leads to inhibition of peristaltic waves and closure of the cardiac sphincter. Division of the vagus nerve is followed by definite obstruction of the oesophagus from persistent tonic contraction of the cardiac sphincter which can be relieved

by division of the sympathetic; so that the sympathetic nerves are in constant action.

Spasm of the Upper End of the Oesophagus occurs in women more often than in men, particularly in nervous individuals, and is associated with anaemia. This anaemia may be due to starvation. Sometimes the spleen is enlarged. The tongue is smooth and has patches of glossitis. The mucous membrane of the pharynx is thin and atrophic. Radioscopy reveals the delay in the passage of food from the pharynx into the oesophagus. Patients suffering from this condition are prone to malignant disease of the pharynx.

The treatment is the dilatation of the strictured area under direct vision with the oesophagoscope. Relief is usually immediate but the dilatation may have to be repeated.

Spasm at the Lower End of the Oesophagus.—This is also designated cardiospasm and achalasia. It has been pointed out that the sphincter at the lower end of the oesophagus is situated where the tube passes through the diaphragm and is therefore 2 inches above the junction of the oesophagus with the stomach. This led to one view that the obstruction was in reality due to contraction of the muscle of the diaphragm itself around the tube. There is, however, no corroborative evidence that this is true, and it is more reasonable to regard the conditions as due to a true spasm of the oesophageal muscle due to some nerve disturbance, particularly as degenerative changes in Auerbach's plexus have been described in this region in achalasia of the oesophagus. There is also found, in cases which have lasted for a long time, a fibrosis in this region, so that what begins originally as a pure spasm may persist as a fibrous contraction.

Cardiospasm is much commoner in women than men and occurs between 20 and 40 years of age, at a time when carcinoma is unusual. The oesophagus above the diaphragm is much increased in diameter and the wall is hypertrophied. There is some oesophagitis, and ulceration of the mucosa may be seen. Sometimes the tube is increased in length so that it is folded into a loop just above the diaphragm.

The dysphagia is apt to come on suddenly. It is not slowly and relentlessly progressive as in carcinomatous stricture. There are times when the patient can swallow quite well. But though there are these intermissions, on the whole the difficulty increases until ultimately only liquids can be forced by an effort into the stomach. Sometimes swallowing is painful; there may be actual oesophageal colic. Regurgitation of undigested food is a prominent symptom. In later stages the eructations are exceedingly foul from decomposition of the retained material. Hiccough is frequently an irksom

symptom. For years, during the time that intermissions occur, the general condition may remain quite good, but ultimately wasting and other signs of starvation set in. Patients with cardiospasm are apt to be of the highly-strung emotional type.

The diagnosis is made from the symptoms, radioscopy and oesophagoscopy. By this latter examination the oesophagitis and dilatation are revealed, and the tight contraction at the level of the diaphragm where the mucosa is thrown into longitudinal folds. Steady pressure at first increases the spasm, but later relaxation occurs and the instrument can be made to pass into the stomach.

The treatment of the condition is rather difficult. Foods which are likely to cause irritation must be avoided. Also alcohol. Anti-spasmodics such as bromides, atropin or papaverin are not of much use. Sometimes the nutrition has suffered so much that a gastrostomy is required to save life. Whether this be done or not, it is necessary to carry out dilatation treatment. This may be done with a rubber tube containing mercury whose weight pressing on the stricture causes the spasm to give and allow the tube to enter the stomach. The patient may be taught to pass the tube himself, which he does before every meal.

In inveterate and resistant cases it may be necessary to open the stomach and dilate the spasmodic area by the fingers from below.

Heller's operation is a better procedure. The abdomen is opened by a paramedian incision and the lower end of the oesophagus exposed by cutting the left lateral ligament of the liver which allows this viscus to be pulled to one side. The muscular coat of the cardia and of the oesophagus and stomach each side of it are incised vertically until the mucosa bulges into the wound. The operation is as successful as Rammstedt's operation upon the pyloric sphincter.

When there is much elongation of the oesophagus which rests in a fold on the upper surface of the diaphragm, it is sometimes possible to perform a lateral anastomosis between the dilated oesophagus and the stomach after pulling the oesophagus downwards into the abdominal cavity through a hole made in the diaphragm.

CHAPTER XXVI

ABDOMINAL WALL AND PERITONEUM

Abdominal Wall

The abdominal wall is subject to the same disease processes as the skin, fat and muscles of other parts of the body. An injury may cause a haematoma in the rectus sheath from rupture of the rectus muscle (page 542) and it may suppurate. The characteristic post-operative gangrene described on page 54 is also sometimes seen.

Tumours.—Innocent tumours are lipoma, papilloma, neurofibroma of von Recklinghausen type. A rodent ulcer is sometimes seen.

Spontaneous epithelioma is not of a very malignant type and seldom gives rise to metastases in the regional glands. Bad examples, however, sometimes occur as the result of radium or X-ray treatment. A carcinoma appearing in an abdominal scar or sinus is serious. Such growths have probably arisen at some distance from the surface so that when first observed they have already invaded the body cavity and are inoperable.

Metastatic carcinoma is frequently found in the neighbourhood of the umbilicus because of the latter's lymphatic connection along the ligamentum teres with the liver and along the urachus with the urinary bladder. It designates serious intra-abdominal carcinoma.

A primary epithelioma should be removed but it is unnecessary to clear out glands in the axilla or groin unless they are enlarged. A radium carcinoma should be widely excised and a plastic operation carried out to cover the raw area.

Sarcoma, neurogenic or spindle-celled, is usually well advanced when first seen. A wide removal is necessary. If diagnosed before operation radium might be used, as these tumours are radio-sensitive.

A malignant melanoma may develop in a mole. It is most dangerous when it grows from the umbilicus, for from here it quickly spreads to the axilla, groin or liver. It is not radio-sensitive. Wide removal with excision of the axillary or inguinal and iliac glands is indicated.

Desmoid Tumour.—This peculiar growth is an infiltrating non-encapsuled fibroma of the rectus sheath or sometimes of the fascia of the external oblique. It nearly always occurs in young women who have recently been pregnant. In shape it is rounded or oval, its surface smooth or nodular. It compresses and then invades the underlying muscle, but it rarely goes through to the peritoneal cavity. After a limited excision these tumours recur. They may turn into a low-grade sarcoma but never cause metastases. They must be widely excised and the resulting gap in the abdominal wall closed by some plastic procedure.

The Umbilicus.—The omphalo-mesenteric duct may remain open (patent Meckel's diverticulum). There is a bright-red nodule at the umbilicus with a velvety surface from which drain mucus and intestinal contents. The skin around shows signs of irritation. The lesion must not be confused with the button of granulation tissue which remains when the cord comes away. If the intestinal end is closed, mucus only escapes. Sometimes both ends are closed, when the duct distends into a vitelline cyst attached to the abdominal wall or intestine. Or it may be represented only by a fibrous band which later in life may lead to intestinal obstruction.

The urachus only rarely remains patent, forming a urinary fistula. But later in life as a result of stricture or enlarged prostate a partially persistent urachus may help to form such a fistula at the umbilicus. Also such a remnant may develop into a urachal cyst which, becoming infected, forms an abscess in the abdominal wall.

Peritonitis

A sound knowledge of the reaction of the peritoneum to irritation and injury is indispensable for the performance of rational surgery in the great abdominal cavity. The total surface area of the peritoneal membrane which covers the contained viscera as well as lines the walls of the space is almost vast compared with the overall size of the cavity, and assumes importance from the fact that it has active absorptive properties. It explains the rapid onset of collapse and quick death when a bacterial process spreads unhindered within it. The phenomena of absorption from the peritoneal cavity have been much studied, but experiments from which clear answers can be expected are difficult to devise, so that much still remains obscure. It is certain that there are not lymphatic stomata on the under surface of the diaphragm as at one time thought. These have been proved to be artefacts. And there is no reason to suppose that there is more rapid or easy absorption from the upper region of the cavity than from any

other part. Whilst the passage of substances into the lymphatics is easily demonstrable, absorption into the blood-vessels is much more active. The rate of absorption is affected by the tonicity of the fluid, by its actual pressure within the abdomen, and by peristalsis. Motionless intestine and an intra-abdominal pressure above that of the diastolic pressure of the blood inhibit the passage of fluids into the blood-stream. The tight, distended, constipated abdomen of severe peritonitis is a protective phenomenon and should not be interfered with.

The power of forming adhesions which the peritoneum possesses is of much significance. When two portions of the alimentary canal are sutured together with aseptic precautions, the injury sets up a local inflammatory reaction which results in their permanent union. The opposing surfaces become glued together by a fibrinous exudate which microscopically is found to be fibrillary in nature. After 4 to 7 days the fibrils which run transversely from one surface to the other seem themselves actually to be converted into connective tissue fibres. It is this rapid union of peritoneal-covered surfaces together which makes intestinal anastomoses possible, for it is found after such operations that the healing of the muscular and mucous coats takes several weeks. The absence of a serous covering explains the invariable leakage which takes place when an attempt is made to resect and join up the oesophagus, or after anastomoses of the non-peritoneal-covered rectum. Hence the need first discovered by Travers, a London surgeon, for the inturning of the peritoneum in all such operations. The necessary seromuscular stitch was afterwards named after Lembert.

Besides these permanent adhesions a curious happening is the formation and disappearance of temporary adhesions. This occurs when there has been a bacterial infection of not too great an intensity. The fibrin which then glues the viscera together is not of a fibrillary nature but granular in character. When the disease subsides this granular fibrin is invaded by cells and removed, the viscera separating from one another. Nothing is more surprising than the extraordinary way in which, after an attack of appendicitis, the numerous adhesions which matted the viscera together in the right iliac fossa into a palpable lump, disappear in the course of a month or two, and leave the appendix free.

Finally, when the peritoneum is subjected to a sudden intensely virulent infection, the fibrinous exudation poured out is neither fibrillary nor granular, but structureless and amorphous. It is a very feeble agglutinating medium, easily broken down to allow a spreading diffuse peritonitis to develop almost without hindrance.

The parietal peritoneum alone is supplied with medullated sensory nerves, the visceral layer has only a sympathetic innervation. The result is that while the former is sensitive to the ordinary pain stimuli, the viscera do not feel a prick, a cut or a burn. Yet it is elementary knowledge that visceral affections can be extremely painful. The hollow viscera are indeed acutely sensitive to distension or to dragging on their mesentery.

Peritonitis may be aseptic or chemical, as, for instance, when there has been an intraperitoneal haemorrhage or the torsion of an ovary, but much more often it is due to a bacterial infection. The commonest source of infection is a perforation somewhere in the alimentary canal. Bacteria may also reach the peritoneum through the walls of the gall-bladder or the canal of the Fallopian tube. Quite rarely there is a blood-stream infection. This seems always to be due to a microbic embolus in the wall of the intestine from some distant source, though the actual lesion in the gut may be easily overlooked. In septic peritonitis there is usually such a mixture of organisms that it is difficult to say which are of most importance or mainly responsible. The *Bacillus coli* is always present in great numbers but the streptococci, which are almost invariably present, are probably the more harmful. Staphylococci, the *Bacillus pyocyaneus*, and the bacillus of Welch, are frequently found. The tubercle bacillus, the pneumococcus and the gonococcus give rise to special varieties of peritonitis.

Peritonitis may be localised or diffuse. It is never generalised throughout the peritoneal cavity, as the patient dies before this can take place. In the localised form the omentum and neighbouring viscera become agglutinated together and the spread of the disease limited. The omentum always travels to any region of the abdomen where there is an inflammatory process going on. By becoming adherent it will often shut off an infection or even close a perforation. Why, in this natural mechanism of defence, the omentum should so surely travel to the site of injury is not altogether clear. It may be that peristalsis is first abolished at that place whilst it continues elsewhere in the abdomen, and that the omentum, passively pushed from pillar to post, ultimately and conveniently settles down in this quiescent area. The infected spot being thus isolated, the whole inflammation may subside or an abscess may form within the adhesions. Such an abscess may actually be absorbed, or it may extend and discharge on to the surface of the body or into a hollow viscus, or, much worse, leak into the general peritoneal cavity. This is serious because it is an indication of the ebb of local immunity. However prompt and energetic, mechanical surgical measures may signally fail to

restore it; on the contrary, they may in fact render the patient's chance of recovery more remote.

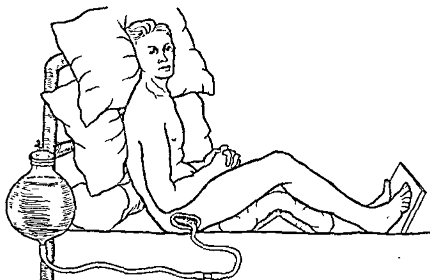
The cardinal signs of peritonitis are pain, vomiting and rigidity, tenderness and distension of the abdomen, constipation and the most intense signs of toxaemia. The temperature is high and the pulse corresponds, but as the toxaemia increases the temperature falls whilst the pulse continues to rise. The patient then assumes a characteristic appearance. He lies perfectly still with sunken cheeks and hollow staring eyes. His skin is cold, clammy and bluish in colour. His pinched fingers are often picking at the bedclothes. He secretes no urine. He is without pain, and conscious, but apathetic. The tenderness of the abdomen is a guide to the site of origin of the disease, as it is most intense in this situation. Rigidity, whilst it is a most valuable and reliable sign, is dependent upon the nerves in the parietal peritoneum being stimulated. If the inflammation is wholly within the pelvis, rigidity may be wanting. The signs of extreme toxaemia and collapse are scarcely compatible with recovery. Such patients nearly always die.

From what has been said the aims of treatment are abundantly clear. The primary object of surgery is the removal of the source and origin of the infection. But while it is nearly always right to close a perforation there are circumstances when it is dangerous and wrong to take away an infected appendix, for, in doing so, a fatal extension of the infection may be brought about. Too much stress, however, must not be laid upon this aspect of the question and allowed to invalidate the general indication for removal of the source of the infection.

Patients with peritonitis are nearly always nursed in the sitting position (Fowler's position) because it is thought, probably erroneously, that this lessens the likelihood of the infection reaching the upper regions of the abdomen. In the supine position the lumbar spine bulges forwards and the exuded fluid is directed by it upwards towards the diaphragm or downwards into the pelvis. In the sitting position gravity causes the fluid to collect in the pelvis, as can be demonstrated in any perforated gastric ulcer. Peritonitis confined to the pelvis is much less serious than inflammation in the upper abdomen. For this reason the Fowler position would seem to be indicated in such cases. But infection of the subphrenic space is probably due in most instances to the suction action of the diaphragm (see page 336). After a clean abdominal operation a patient is more comfortable if he is allowed to lie flat for sleeping and even turned on his side than in the sitting position, which need not be insisted upon unless it eases his breathing. The view that pressure of the knee pillow on the calf causes pulmonary embolism is not very reasonable.

After fractures of the leg, patients lie for weeks with their legs resting upon a posterior splint, often a hard plaster with the knee flexed. They do not get emboli, which is a condition so much more frequent after an abdominal operation that there must be some connection between the abdominal procedure and the embolus formation.

Water is administered rectally by the Murphy method. It should be in a container kept at a few inches only above the level of the rectum. There should be as large a bore as possible to the tube passing from the container and no clip should be allowed to be placed upon it, nor should a drip indicator be interposed. Under these



Fowler's position and the Murphy drip. Note the knee pillow and foot-rest, the low level of the saline container, and the unobstructed rectal tube.

conditions the water runs in under the very low pressure of a few inches, the rectum cannot be distended, and the patient, at need, can expel flatus through the fluid in the container without discharging unabsorbed saline into the bed. If the patient does not absorb water by this route normal saline should be administered intravenously. If the peritoneal exudate is so profuse as to lead to a significant loss of protein, plasma should be given; and perhaps, as in burns, 2 per cent sodium lactate by mouth may be of use. No enemata or aperients should be given, because immobility of the intestines should be encouraged. For this reason morphia is indicated as well as for the relief of pain and the bestowal of sleep. Distension of the abdomen by raising intraperitoneal pressure diminishes absorption. Brandy and cardiac stimulants have their place. Radiant heat to the abdomen by electric bulbs hanging from a cradle is said to help in resolving the intra-abdominal inflammation. Sulphonamide drugs may be of use. Penicillin is inactive against the *Bacillus coli, enterococci* and *proteus,* so does not play a great part here.

Tuberculous Peritonitis

This form of peritonitis is nearly always chronic in type and as a rule affects children. It is a secondary lesion. The peritoneum may have become affected from a tuberculous mesenteric gland, appendix, Peyer's patch or Fallopian tube. Quite rarely the blood-stream brings the infection from some distal focus such as a tuberculous lung. There are several varieties.

Tuberculous Ascites.—The child becomes at first vaguely ill. He gets tired easily, sits about instead of playing, loses his appetite and perhaps has diarrhoea. Whilst generally he gets thinner his abdomen begins to swell, presenting a striking contrast to his peaky face and skinny limbs. There is an evening rise of temperature which may run up to 103° F. Fluid may be demonstrated in the distended abdomen by movable dulness in the flanks. Sometimes there are irregular masses to be felt in the region of the caecum or elsewhere. At others the collection of fluid is localised—the encysted form. There is no pain.

An abdominal section below the umbilicus is recommended. It settles the diagnosis, hastens the cure and perhaps allows of the removal of the primary source of the infection. The remarkable amelioration which follows the simple evacuation of the fluid is attributed to the fact that fresh fluid, rich in immune bodies, replaces the exudation which has become exhausted of all protective substances. The fluid found on opening the abdomen is yellowish green in colour. The peritoneum is studded with little greyish translucent nodules, the size of a millet seed, which have a tendency to run together to form larger masses. The peritoneal membrane itself is thickened, oedematous and reddened. Exploration may reveal the primary focus, which, if appendix or Fallopian tube, should be removed. Tuberculous mesenteric glands are usually better left alone. A drainage tube may be left in for 24 hours but no longer. Children who have suffered from this form of tuberculous peritonitis often grow up to become healthy adults.

Adhesive or Plastic Tuberculous Peritonitis.—In this variety there is little or no fluid poured out. The tubercle-studded peritoneum becomes covered with a shaggy fibrinous exudation which glues the viscera together and to the abdominal wall. The substance of the omentum and the walls of the intestine become invaded with tuberculous granulation tissue. The growth of this tissue and its fibrous transformation often lead to the formation of quite large masses of irregular shape distributed about the abdomen. Cold abscesses may develop and cicatrisation lead to intestinal obstruction. The wall of

the intestine infiltrated with tuberculous granulation tissue becomes very friable.

The plastic variety of the disease is met with in young adults as well as children. There are the same lassitude and general failure of health, but the abdomen presents quite a different picture. Instead of being greatly swollen it is only slightly tumid. On palpation it is usually said to feel doughy, but the sensation is more like what one would expect if the abdomen were lightly stuffed with wool or tow. The harder irregular masses, already mentioned, can be felt. Attacks of pain and vomiting, accompanied by visible peristalsis, denote attacks of intestinal obstruction. Sometimes a secondary infection will invade a cold abscess, turning it into an acute suppurative lesion. A frequent symptom is pain on urination.

An operation should never be carried out on these patients unless there is intestinal obstruction or an abscess needs opening. The walls of the intestine are so softened that exploration or manipulation may easily result in the bowel being torn. The diseased bowel repairs very badly so that a faecal fistula is common after these operations. It is often better to short-circuit the bowel than to attempt to separate adhesions for the relief of obstruction. The prognosis in this form of the disease is not so good as in the ascitic form but many patients, with prolonged open-air treatment, get perfectly well.

Suppurative Tuberculous Peritonitis.—This is a very acute variety in which the abdomen becomes filled with pus of a greenish colour. It is not of very great importance surgically because it usually occurs in patients in the last stages of phthisis, or advanced tuberculosis elsewhere. The whole peritoneum is studded with miliary tubercles.

Pneumococcal Peritonitis

Infection takes place from the Fallopian tubes or by the bloodstream. In the latter case there is a primary pneumococcal focus in the lung or middle ear, or elsewhere. The clinical features vary very much. In the worst cases there is a septicaemia, and the patient quickly succumbs to this general infection. In the direct form of the disease, that is, the disease due to spread from the Fallopian tubes, there is an attack of pain and vomiting, with a high temperature and diarrhoea. Rigidity and tenderness are present in the lower abdomen, and there is often pain on micturition. About the third day there comes on extreme prostration, with restlessness, cyanosis and delirium. The patient is usually a child. Much more rarely the same type of disease occurs in boys when it is a blood infection.

In other instances the illness is much milder. The abdominal

signs largely fail; there are only a discomfort and a slight muscular resistance; after some days of gradual distension, a tumour in the abdomen is felt; it is a localised abscess.

When the disease is secondary to pneumonia, the diagnosis is clear, but in primary direct cases it is very difficult to decide whether the child is suffering from pneumococcal peritonitis or appendicitis. Unless the surgeon is quite sure, it is better to operate, as it is a serious matter to leave a child with acute appendicitis. But when the diagnosis is certain it is advisable to wait with the hope that a localised abscess will form, as the prognosis is better if the operation is delayed to this stage. Penicillin is strongly indicated. On exploring the abdomen in doubtful cases there will be found a pelvic peritonitis with much fibrin about; the most intense inflammation is in the region of the Fallopian tubes. The abdomen should be drained.

The prognosis in this disease is not very good; death frequently occurs in the septicaemic stage.

Subphrenic Abscess

The subphrenic space is that region which lies between the diaphragm above and the transverse colon and the transverse mesocolon below. Infection, when it occurs here, is likely to be limited by anatomical structures to a particular part of this space, so that subphrenic abscesses can be classified according to the area to which the pus is localised. This classification, however, lacks precision and is a little artificial in nature. The coronary ligament of the liver above and the falciform ligament below certainly divide the space into right and left areas. On the right side the right lateral ligament of the liver divides this part into an anterior and a posterior compartment, so that right anterior and right posterior intraperitoneal subphrenic abscesses are recognised. The right anterior abscess is particularly likely to spread around the margin of the liver into the subhepatic space (subhepatic abscess). On the left side the anterior peritoneal abscess lies between the anterior abdominal wall in front and the liver and stomach behind, the diaphragm forming the roof above, and the adhesions of the transverse colon and the omentum to the abdominal wall, the floor. The abscess may spread round to the spleen and the kidney behind. The left posterior intraperitoneal abscess lies behind the stomach. It is an abscess in the lesser omental space. Besides the abscesses already described, there are also right and left extraperitoneal subphrenic abscesses which form in the extraperitoneal tissue around the adrenal bodies and the upper ends of the kidneys. Finally, a suppuration may occur in the loose tissue lying between

the layers of the coronary ligament (central extraperitoneal subphrenic abscess).

The majority of subphrenic abscesses arise as the result of suppuration within the abdomen. More than half are due to appendicitis or to the perforation of a gastric or duodenal ulcer. The next common cause is an infection in the gall-bladder or suppuration within the liver. Uncommon causes are suppuration in the pancreas or spleen or osteomyelitis of the spine. A perinephric abscess may spread to the subdiaphragmatic space. Infection reaches the subphrenic space from a suppurative focus in the lower abdomen by the spread of the pus through the peritoneal cavity along the paths of least resistance. It is suggested that the pus is actually sucked upwards because experiments have shown that the pressure in the subphrenic space is slightly negative during quiet respiration, and more negative during inspiration than during expiration. From the appendix the pus usually travels up the groove on the outer side of the ascending colon to reach the right anterior or right posterior space. Or, if the infection has penetrated into the subperitoneal tissue, it may pass upwards behind the peritoneum to form an extraperitoneal abscess. Much more rarely, a left intraperitoneal abscess is found complicating appendicitis. Extension to the left side takes place by one of two routes. Between the origins of the mesosigmoid and the mesentery there is quite a narrow groove leading upward and to the left. If the appendix lies beneath the lower end of the mesentery pointing upwards towards the spleen, it is in a favourable position for the pus to set out in this direction, attain the left of the duodenojejunal flexure, pass in front of the deeply lying splenic flexure of the colon and enter the left subphrenic space. The other route is by way of a pelvic abscess, then upwards and to the left along the under side of the mesocolon and the outer side of the ascending colon. The organisms found in a subphrenic abscess are those commonly associated with septic peritonitis; the *Bacillus coli*, the streptococcus and the staphylococcus.

A subphrenic abscess is more often found on the right than on the left side and for some unexplained reason is commoner in males than females. The symptoms of subdiaphragmatic peritonitis begin 10 days to 3 weeks after some intraperitoneal suppurative inflammation has occurred. It may begin with a rigor, but perhaps more often there is nothing more than a persistence of a high temperature which cannot be accounted for by spread of the infection elsewhere. In many cases the diagnosis is difficult and indeed the infection frequently seems to subside spontaneously without going on to suppuration. Abdominal signs occur if the abscess is anterior. There may be an actual bulging visible which is limited in the middle line by a border

convex towards the sound side, due to the bulging of the falciform ligament. The lower border formed by adhesions of the transverse colon and omentum to the anterior abdominal wall is recognised by a band of tenderness running obliquely upwards and outwards from the umbilicus. The abscess itself is dull to percussion unless it contains gas, which it is apt to do if it has resulted from rupture of the stomach or duodenum, in which case the resonant bubble may be detected moving its position when the patient turns on his side.

A posterior intraperitoneal abscess may show no detectable abdominal signs at all, but there is often tenderness along the course of the twelfth rib.

The diaphragm is raised so that normal resonance of lung fails to reach as low a level as usual. In addition to this the infection below the diaphragm is very likely to spread through to the pleural cavity. Then there will be signs of fluid with compression of the base of the lung. There is always a persistent leucocytosis. The X-ray is of very great assistance in the diagnosis. It will demonstrate elevation and immobility of the diaphragm and perhaps the presence of a gas bubble beneath it.

Whilst spread of infection from above the diaphragm to the space below is exceedingly unusual, extension in the other direction is frequent so that an empyema is a common complication of a subphrenic abscess. Rarely an actual perforation of the diaphragm leads to the formation of this complication; but this event, if the lung has already become adherent to the diaphragm, causes a pneumonia and perhaps the perforation of a bronchus with evacuation of the pus by the air passages.

The presence of a posterior subphrenic abscess unaccompanied by definite physical signs can be established by diagnostic puncture successively if necessary, in the tenth, ninth and eighth intercostal spaces in the posterior scapular line; but this measure is fraught with the danger of infecting an unobliterated pleural cavity and is only used when the surgeon is prepared, should he find pus, to carry out a drainage operation. Respiratory movements of the outer end of the exploring needle when it has penetrated through the diaphragm will serve to show that the pus is not coming from a simple empyema. Nowadays skiagraphy has rendered exploratory puncture unnecessary.

The outlook in subphrenic abscess is very grave. Without operation all the patients die. Even with drainage more than one-third suffer the same fate. It would seem to be a great advantage if drainage can be accomplished without any contamination of the rest of the peritoneal or of the pleural cavity.

Anterior abscesses, when they bulge towards the abdomen, are

opened from the front. An incision is made just below the costal margin and the muscles separated until the extraperitoneal tissue is reached. The finger burrows up in this tissue beneath the diaphragm until the abscess is reached, when the peritoneum is usually so softened that the finger breaks through it and enters the abscess cavity. A drain can then be inserted.

Posteriorly situated abscesses are reached by subperiosteal resection of the twelfth rib. An incision is then made through the deep periosteum of the rib at the level of the spinous process of the first lumbar vertebra. This will always be below the lower border of the pleura. In the same way as in the front the finger burrows upwards in the subperitoneal tissue beneath the diaphragm and so into the abscess. The old transpleural approach has been shown to have a considerably higher mortality.

CHAPTER XXVII

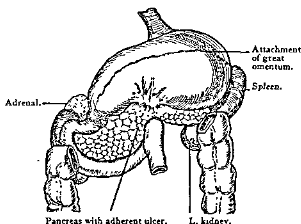
DISEASES OF THE STOMACH AND DUODENUM

Gastric and Duodenal Ulcers

There are two kinds of gastric ulcer, the acute and the chronic.

Acute Gastric Ulcer

The acute ulcer is always a small lesion and involves nothing more than the mucous membrane of the stomach. It is due apparently to an infection from some septic focus in the body, perhaps in the tonsils, or teeth, or middle ear, or elsewhere. It causes some indigestion, but the most characteristic symptom is haemorrhage from the stomach. The haemorrhage may be so profuse as to threaten life. It occurs usually in young people. The condition should be treated by morphia, intravenous saline and blood transfusion, as any attempt to find the ulcer by operation is likely to fail; the ulcer is not visible from the outside of the stomach, and if the viscus be opened it will very likely be overlooked, as it is often a mere cleft in the mucous membrane.

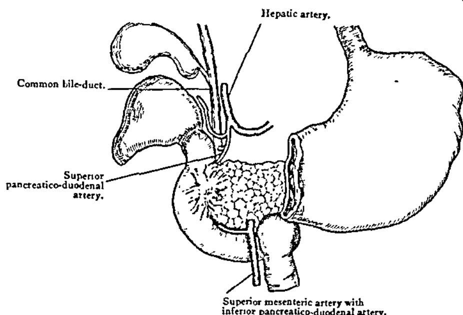


Stomach turned upwards to show an ulcer on its posterior wall adherent to the pancreas.

Chronic Ulcer of the Stomach and Duodenum

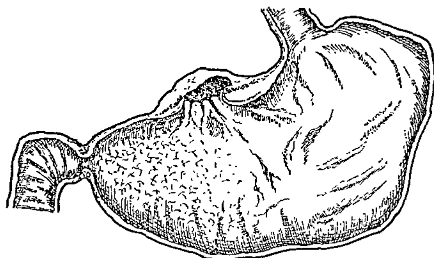
This is a very specialised form of ulceration in the stomach and duodenum. It is found usually on the posterior wall of the stomach near the lesser curvature, and in the first and second parts of the duodenum; much less commonly in the other parts of the stomach and never beyond the opening of the common bile-duct into

the duodenum. On page 343 is shown the frequency in the different parts of the stomach. Gastric ulcers are much larger than duodenal ulcers as a rule. They may be immense in size but usually they are about



Stomach cut across and turned over to the right to show an ulcer on the pancreatic wall of second part of duodenum.

1 cm. across. In the duodenum a lesion of this size is uncommonly large: duodenal ulcers are commonly but a few millimetres in diameter. The gastric ulcer is typically circular in shape; its oral edge is over-



Chronic ulcer of lesser curvature with extensive fibrosis around it. Note the overhanging edge on the oral side and the shelving edge on the aboral side.

hanging, its aboral margin shelving. There is a layer of necrosed tissue in the base of the ulcer, and outside this granulation tissue and then a fibrous tissue zone. The area of this fibrosis is very great; it extends widely into the surrounding structures, particularly into the

lesser omentum and into the pancreas, to which the ulcer very frequently becomes adherent. This same extension of the inflammatory process takes place with duodenal ulcers; here it spreads into the gastro-hepatic omentum where it obscures the structures in the free margin, and into the pancreas. Such a hard mass may be formed in the pancreas and wall of the duodenum, that a malignant growth may be simulated. The fibrosis also sometimes extends to the pylorus, causing obstruction there. A gastric ulcer, by causing cicatrisation in the wall of the stomach, may produce a constriction in the middle of the body of this organ (hour-glass stomach). The coronary, splenic or pancreatico-duodenal arteries may be eroded by the ulcerative process and lead to a massive haemorrhage. Many gastric and duodenal ulcers heal as the examination of bodies *post mortem* shows; but there is a great tendency to relapse, and especially does this happen in the autumn and spring. The disease is one which affects adults from 30 to 40 years of age, but it is seen occasionally in very young people, and is fairly common from 40 to 50.

The aetiology of these ulcers is very obscure. Several hypotheses have been advanced: they are (1) the neurogenic, (2) the idea that a portion of the stomach dies and is then digested, (3) the infective.

The results of experiments upon animals will be described first.

Cushing noticed that a certain number of patients with brain tumours died from the perforation of a gastric ulcer. In consequence, experiments have shown that electrical stimulation of the hypothalamus will give rise to patches of hyperaemia and ulcers in the mucous membrane of the stomach. This apparently happens through the vagus which liberates acetyl choline, and thus induces areas of anaemia in the stomach.

Gastric juice does not ordinarily digest the walls of the stomach, but when it escapes upon the surface of the body, it sets up an inflammation and ulceration. If an area of the wall of the jejunum, or ileum, or colon or the spleen be implanted into an aperture in the stomach, provided the vascular supply is undamaged, no ulceration of these structures occurs. On the other hand, Mann and his collaborators have shown that if, in the dog, the duodenum is cut across just beyond the pylorus, and the proximal end implanted into the lower part of the ileum, an ulcer almost certainly develops. If the implantation is made higher up into the jejunum, an ulcer forms in only a proportion of animals. The explanation of the difference is thought to lie in the fact that in the upper implantation neutralisation is more possible with the duodenal and pancreatic juice, and bile. Similarly the implantation of an isolated Pawlow pouch into the ileum always leads

to the formation of an ulcer, whereas if it is put into the jejunum a positive result is got in only a few cases.

Curiously enough ulcers have but very rarely been seen in a Pawlow pouch, probably because the juice is allowed to escape and so is not for long in contact with the mucous membrane. It is also pointed out that pure gastric juice contains 0·5 per cent of hydrochloric acid, whilst the percentage of the acid in the stomach juice withdrawn after a test meal is 0·1 to 0·2. Not only does protein combine with the hydrochloric acid, but neutralisation also occurs from the reflux of duodenal juice through the pylorus. Experiments have proved that if either pancreatic juice or bile are deviated from the duodenum, ulcers may form. Again, by putting an ingenious valve into the pylorus which allows egress of the chyme but no reflux of duodenal contents, the acidity of the stomach contents is raised, whilst acid introduced into the stomach is more slowly neutralised.

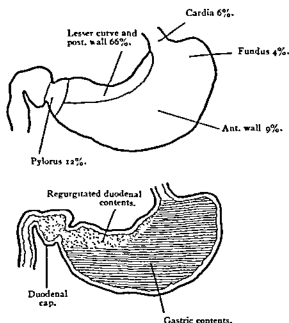
The infective idea of the origin of gastric ulcers rests upon the experimental work of Rosenow who, by injecting intravenously into rabbits cultures of streptococci obtained from human ulcers, caused ulcers to form in the stomachs of these animals; but only when the dose was massive.

Perhaps all these three hypotheses have some element of truth in them. Certainly in man worry does seem to have some effect in aggravating the symptoms of gastric and particularly of duodenal ulcers, and in this connection it must be remembered that the seat of the emotions is thought to be the hypothalamus.

As regards the part played by the gastric juice in causing ulcers, it is interesting to note that ulcers are uncommon in the part of the stomach where there are the most acid-secreting cells; the secretion both of the pyloric and Brunner's glands is alkaline. The peculiar distribution of ulcers needs some explanation. It is said that the absence of folds of mucous membrane along the lesser curvature may mechanically lead to the gaping of small excoriations from the passage of food in this situation, and so give a chance for the gastric juice to act; but this explanation does not seem very plausible, because nothing is so striking as the quick way in which operative wounds of the stomach heal, whether they are in the body of the stomach or at the lesser curvature. It does seem, however, that the conditions for ulcer formation are favourable where the duodenal secretions mix with the pyloric juice; for, during digestion, when reflux of the contents of the duodenum takes place, it is pretty certain that the liquid runs backwards along the magenstrasse. This corresponds to the area where gastric ulcers are found.

The higher acidity found in the test meals of patients with duodenal

ulcers is attributed to the failure of the ordinary reflux from the duodenum into the stomach; in which case the mixture of gastric and duodenal juice occurs in the duodenum itself. Again the same conditions are present just beyond the opening of a gastro-jejunostomy, where ulcers form occasionally. Then it is well known that a persistent Meckel's diverticulum may have areas of gastric mucosa within it, and that in such cases where the secretion of the diverticulum meets the contents of the small intestine, that is, in the ileum just at its mouth, a typical peptic ulcer may form. All one can say,



however, is that the combination of these two secretions, namely that of the duodenum and that of the pyloric part of the stomach, can bring about conditions favourable to the formation of peptic ulcers. Rosenow's experiments do not seem to apply to the human disease. In the first place, as likely as not, the culture of an excised ulcer will prove negative. And although the injection of minced human ulcer, or the implantation of a piece of it under the mucous membrane of the stomach of a rabbit, never gives rise to an ulcer, this does not prove that ulcers have not an infective origin; for one of the difficulties of these experiments is that human gastric ulcer appears to be a specific human disease from which no animal suffers and to which no animal is susceptible. Indeed there are certain facts about gastric ulcers which point to their being infective in nature. The peculiar way in which the symptoms come and go, the freedom for long periods, are what one would expect with the varying resistance to an infection. The very great fibrosis all round, and at some distance

from an ulcer, which is such a prominent feature, cannot be due to the diffusion of acid juice, for the reaction of the tissues is alkaline. The fact that when the gastric juice is deviated to the lower end of the small intestine, where there are the most bacteria present, ulcers are more common than when the juice is allowed to enter the upper part of the jejunum, may perhaps be an argument too. Finally, it must be remembered that none of the ulcers obtained experimentally have been proved to be identical with the human disease.

The symptoms of gastric ulcer are distress or pain after food, and vomiting. The pain may occur very soon after meals or there may be a delay of some time up to an hour or more. The typical sequence is food, pain, relief, food, and so on. With duodenal ulcer the pain is late, one to two hours after food, and the taking of a meal gives relief; the sequence is food, relief, pain, food. Vomiting, which brings relief from the pain in gastric ulcer, is not quite so common in duodenal ulcer. The physical signs of these ulcers are not very distinctive. With gastric lesions there is a tenderness in the epigastric angle wherever the ulcer is situated. With duodenal lesions the tenderness is often in the right hypochondrium. Tenderness to the right or left of the dorsal spine is sometimes found to be present. If a duodenal ulcer has caused stenosis of the pylorus, shaking the patient will give rise to splashing sounds; and in advanced cases peristalsis



Ulcer on lesser curvature.



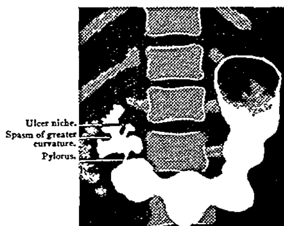
Ulcer on lesser curvature. Upper part of stomach partly empty showing persistent barium fleck and mucous folds radiating from ulcer.

will be visible. Some muscle spasm is caused when the ulcer reaches the peritoneal surface. The two complications of gastric and duodenal ulcers are haemorrhage and perforation. These will be described later.

The existence of an ulcer can only be a surmise until its presence has been demonstrated by an X-ray examination. After a barium meal an ulcer of the stomach is seen as a projection of the lesser curva-

ture of the stomach. Owing to the fact that barium is so heavy, an ulcer on the posterior wall of the stomach adherent to the pancreas appears to be on the lesser curvature in the photograph because the mobile part of the stomach sinks down by its weight making the ulcer crater visible in profile. Opposite the niche of the ulcer on the lesser curvature the greater curvature is often drawn in, in a spasm. There is frequently some delay beyond four hours in the emptying time of the stomach. An area of stomach wall around the ulcer is rendered rigid by the fibrosis, so that in this region peristaltic waves cannot produce an indrawing of the shadow; this can be observed on the screen. At the same time the actual ulcer can often be demonstrated to be tender. When the stomach has emptied itself, a persistent fleck of barium may remain in the ulcer crater.

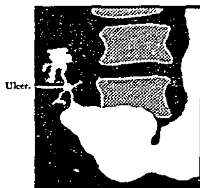
In the case of duodenal ulcers peristalsis is often observed to be very vigorous; in the film three or four waves may be visible at one time, whereas normally never more than two are seen. When chyme passes through the pylorus it is held up for a time in the first part of the duodenum by a physiological spasm between the first and second parts. The shadow thus produced takes the form of



Ulcer of duodenum. Note the hyperperistalsis of the stomach.



Duodenal ulcer. Face view.



Duodenal ulcer. Persistent fleck *of barium in crater.*

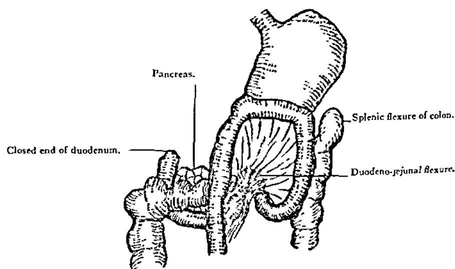
a cardinal's hat; it is called the duodenal cap. When there is a duodenal ulcer present this cap is distorted. Sometimes a definite

crater can be seen with an indrawing of the opposite wall of the duodenum. At other times the most bizarre forms are taken on by the cap of which one, the trefoil type, is rather characteristic. Under screen examination tenderness of the cap can be demonstrated. Although peristalsis is usually vigorous the stomach seems to exhaust itself quickly, with the result that there is often a four-hour residue.

The chemical examination of the gastric contents after a test meal is of help in a duodenal lesion for there is nearly always a hyperacidity, owing to the fact that normal reflux through the pylorus does not take place. There is a high degree of acidity in the resting juice; after the meal the acidity is lowered for a short time, but it soon rises again and remains high. Hyperacidity occurs in only 20 per cent of gastric ulcers, hypoacidity in 13 per cent, and a normal value in the remainder.

The treatment of gastric ulcers is medical in the first instance. That many ulcers heal without operation is proved by the scars seen so often *post mortem*.

Medical treatment will not be described here; its principles are well known—small frequent meals to keep the gastric juice neutralised

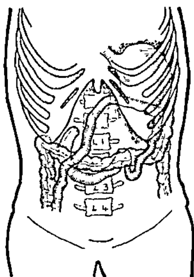


Anterior Polya type of partial gastrectomy.

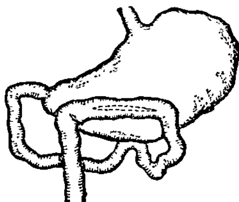
as far as possible (protein in the form of eggs is particularly good for this purpose); fat to relax the pylorus and lead to emptying of the viscus, especially in the form of milk and cream because it is here emulsified and protein is given as well; drugs which will neutralise acid without causing alkalosis, such as calcium phosphate, magnesia or magnesium silicate with the minimum of sodium bicarbonate; above all, physical rest by confinement to bed. When medical treatment has definitely failed, then surgery is called for, and it is remark-

able that the number of good results is so high where medical means have proved wanting.

For the ulcer on the lesser curvature of the stomach or its posterior wall there is only one really satisfactory operation; the whole of the pyloric part of the stomach must be removed to a point just proximal to the ulcer, and the cut end of the stomach implanted into the upper part of the jejunum; the duodenum, which is divided just beyond the pylorus, is closed; the loop of jejunum with which the anastomosis is made is brought up in front of the transverse colon, or through an aperture in the mesocolon. Both these operations are of the Polya type. The open end of the stomach may be joined directly to the duodenum (the Billroth I or Péan operation), which, although it is a very attractive procedure theoretically, does not give such a high percentage of successes as the Polya operation. The mortality of the procedure is low. Sometimes there is great difficulty from the very extensive fibrosis surrounding the ulcer; the stomach is adherent to the pancreas and perhaps the liver, the substance of which may form the base of the ulcer. In such cases the rim of the ulcer is pulled away from the liver or pancreas and the base left *in situ*. High ulcers on the lesser curvature may be removed by a Z-incision of the stomach, an operation which avoids a too extensive resection. When the adhesions to surrounding parts are so great that resection is impossible, then a gastro-jejunostomy will sometimes give relief; if this should likewise be impossible, a jejunostomy alone is sometimes recommended; patients do seem to improve afterwards, but the number of cases is too small as yet to make a true evaluation of the method.

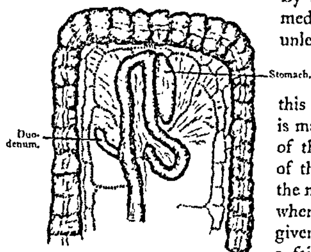


To show how, after resection of the stomach by the anterior Polya type of operation the stomach recedes up under the costal margin, the anastomosis is horizontal, and the afferent limb does not compress the transverse colon because the splenic flexure lies so deeply within the abdomen.

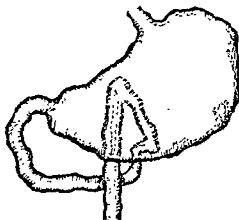


Anterior gastro-jejunostomy.

When it comes to the assessing of the place of surgery in the treatment of duodenal ulcer there is a certain difference of opinion. By some clinicians it is held that medical treatment alone is justified unless there is obstruction of the pylorus, when a gastro-jejunostomy is indicated. In this operation a lateral anastomosis is made between the posterior wall of the stomach and the first part of the jejunum through a hole in the mesocolon. Others think that when medical treatment has been given a good trial and has proved a failure, that gastro-jejunostomy should be done. It cannot be denied that this operation gives relief to many patients who have got nothing from medicine; the actual percentage of cures is 69. The drawback is the fairly high proportion of failures and the risk of a gastro-jejunal ulcer forming, that is, an ulcer in the jejunum just beyond the opening, or at the margin of the stoma. This complication occurs in about 5 to 10 per cent of cases. A much higher number of cures can be obtained if the diseased part of the duodenum be removed together with a large part of the stomach in order to lower the acidity of the gastric secretion (partial gastro-duodenectomy). This operation is technically difficult but has not a high mortality, and it certainly gives a much higher percentage of permanent cures (87 per cent). The procedure is similar to partial gastrectomy except that the duodenum is separated down to a point beyond the ulcer. This is the intricate part of the operation, for, owing to the contraction of the fibrous tissue in the neighbourhood, the common bile-duct and the pancreatic duct are in danger of injury, while haemostasis requires the ligation of innumerable small vessels. However, the better results from this operation and its low mortality (less than 1 per cent) render it the operation of choice. Gastro-



Posterior gastro-jejunostomy. Stomach turned upwards. A part of its posterior wall is pulled through a hole in the mesocolon and sutured to the jejunum.

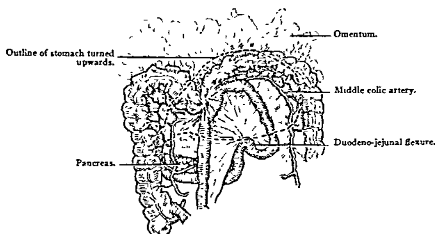

Posterior gastro-jejunostomy.

jejunostomy should never be done in young individuals, but it has a place in older people with healed ulcers and pyloric obstruction, particularly if they are emaciated and weak.

The objection has been raised that extensive resection of the stomach brings with it the danger of pernicious anaemia. This fear is quite unfounded; in actual fact anaemia is very rare after gastrectomy. It has been found that the pyloric part of the stomach is unaffected in pernicious anaemia but that it is the rest of the stomach which has degenerated; it has also been determined that the glands of the cardia and Brunner's glands of the duodenum secrete the necessary intrinsic factor.

Gastro-Jejunal Ulcer

This is a complication of gastro-jejunostomy; it is rare after a partial gastrectomy. The primary operation gives the patient immediate relief which may last for years. As a rule, however, the symptoms of the gastro-jejunal ulcer appear within two years of the gastro-jejunostomy. The condition is very likely to come on in young people in whom a gastro-jejunostomy has been performed.



Gastro-jejunal ulcer adherent to transverse colon, seen on turning the stomach with its omentum, and the colon upwards.

The pain after food reappears and is felt often down the left side of the abdomen. It is very intense, usually much worse than that of the ulcer for which the operation was originally done. Just as in the case of a gastric ulcer, there is likely to be a great deal of fibrosis in the neighbourhood, and the area of the anastomosis becomes adherent to the colon into which perforation may take place. This serious complication causes faecal vomiting and diarrhoea. The patient's

condition is truly pitiable. He has a constant foul taste in his mouth, loses all desire for food and rapidly wastes.

In gastro-jejunal ulceration nothing is of any good but operative treatment. The operation is a serious and difficult one, and has a rather high mortality. The object is to remove the ulcer and so much of the stomach that the acidity will be permanently lowered. This frequently means the resection of a piece of the small intestine as well as the stomach, whilst if there is a gastro-colic fistula the hole in the colon must be sewn up. Restoration of the continuity of the alimentary canal is effected as in the Polya gastrectomy.

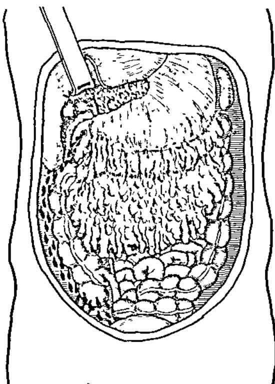
Gastro-jejunal ulcers may perforate into the general peritoneal cavity or give rise to a serious haemorrhage.

Perforation of Gastric and Duodenal Ulcers

It is usually the chronic ulcer which perforates, but the accident occasionally happens with acute ulcers. Ulcers on the posterior walls of the stomach or duodenum become adherent to the pancreas and so they do not perforate into the general peritoneal cavity; on the front of these organs, however, adhesions do not so easily form because of the continual movement of the anterior abdominal wall over them. Hence, except in the very rare event of a rupture into the lesser sac of the peritoneum, a perforation into the peritoneal cavity is always on the anterior aspect of the stomach or duodenum.

There is usually a history of indigestion before the sudden pain in the epigastrium occurs. The pain may be so great owing to the intense irritation of the acid gastric juice that at first there may be considerable shock. This passes off in a short time and the patient may be seen with a pulse rate which is very little above the normal and of good volume. But there is always extreme rigidity of the abdominal muscles which is well described by the adjective board-like. So great is the spasm that the abdomen is often concave (scaphoid abdomen); and the transverse intersections in the rectus muscle stand out very distinctly. There is acute tenderness in the epigastrium and often also in the right iliac fossa. This occurs especially in the case of perforation of the duodenum; the irritating fluid escaping is directed over the hepatic flexure of the colon to the iliac fossa, where, owing to the lesser slope, it delays its progress into the pelvis, and so causes a greater intensity of inflammation at this site. Because of this tenderness these cases are sometimes thought to be acute appendicitis. No mistake will be made if it is remembered that the evolution of the symptoms is far more rapid in a perforation, and that there is the greatest tenderness in the epigastrium, whilst,

if enough gas has escaped from the stomach, the normal dulness due to the liver will be wanting. The irritating acid juice reaching the lowest part of the peritoneum in the pelvis causes inflammation here and so tenderness on rectal examination. Vomiting is not a prominent symptom of perforation of an ulcer. It may occur once at the beginning but usually not after that until septic peritonitis comes on. The peritonitis for the first four to six hours is chemical in nature; at the end of this period the liquid poured out by the inflamed peritoneum neutralises the acid and allows bacteria to grow; the peritonitis is now septic. This explains why the prognosis in the first few hours is so much better than it is later on.



Liquid escaping from a perforation in the duodenum is directed by the hepatic flexure of the colon to the right iliac fossa and thence into the pelvis.

Quite commonly the perforation is sealed off by omentum becoming adherent to the ulcer site. When it does this the symptoms become rapidly better, but as a rule the fibrin is digested away and a secondary leakage into the peritoneum occurs.

Unless an operation is done, the patient dies in two or three days from septic peritonitis. The treatment should be carried out as soon as possible because the prognosis gets worse with the passage of every hour. A supra-umbilical incision is made to the right of the middle line. It need be only a short one as the site of the perforation is known within narrow limits. Whether it is in the stomach or the duodenum it is always near the pylorus, and on the anterior surface. All that is needed is the infolding of the perforation by sutures. It is usually better to put a drainage tube into the pelvis just above the pubes. Gastro-jejunostomy or partial gastrectomy should not be done at the same time. Any temporary obstruction to the pylorus by oedema at the site of infolding can be overcome by the passage of a Ryle's tube.

Haemorrhage from Gastric and Duodenal Ulcers

This is a fairly common and very serious complication. In gastric ulcers the blood is in part vomited up (haematemesis) but in duodenal ulcer no blood may escape from the mouth; it passes on and is manifested as a melaena (black stools). In duodenal haemorrhage the first sign of the condition is a sudden faintness felt by the patient. In these cases there are all the signs of loss of blood. The amount lost varies very much, from a few ounces to more than a pint. A very important fact to remember about these haemorrhages is that they are secondary in nature. The ulcerative process erodes the wall of a large vessel: the coronary or splenic when the ulcer is in the stomach; the gastro-duodenal artery, as a rule, when the ulcer is in the duodenum. After a time clotting takes place and the bleeding stops, but the ulcerative process continuing, the clot is eaten away and the bleeding recurs. There is some reason for thinking that in these cases there may be a secondary infection in the ulcer which may play an important part in causing the haemorrhage.

With rest and medical treatment which nowadays does not call for starvation, and blood transfusion, a large percentage of such patients recover. However, the mortality is greater than was at one time thought. When the haemorrhage is massive the question of operation arises. Surgical treatment has been discredited because of its high death rate. This is because in so many cases operation has been done only when the patient's strength has been sapped by repeated haemorrhages; it has been a last resort. The results of operative treatment are many times better if it is carried out within 48 hours of the onset of the bleeding. In which cases and when to operate is a difficult decision to make. Probably the patient should not be allowed to lose more than one-half his blood, but the haemoglobin estimation is not a good index of this at first. If there is a sudden loss of blood the percentage of haemoglobin will be for a time normal in the blood remaining in the circulation. Only when the loss of plasma has been made good by absorption from the tissues will the haemoglobin fall. In these early stages the blood-volume is an index of the loss of blood. When the volume has been made good by fluid, the haemoglobin or the cell-volume is a better index. Again, a pulse rate of over 100 beats per minute means very serious loss of blood. An operation for the stanching of the haemorrhage may be a formidable undertaking. When the ulcer is on the lesser curvature of the stomach the best treatment is an ordinary partial gastrectomy. Sometimes when the ulcer is on the posterior wall of the stomach burrowing into the pancreas, a simple and effective

procedure is to pull the ulcer off the pancreas, ligate any bleeding-point and suture the opening left in the posterior wall of the stomach. In any case a blood transfusion should be given immediately the operation is finished.

The problem is even greater when the bleeding comes from the duodenum as a partial gastro-duodenectomy is the ideal treatment. Should the patient be too ill to withstand this and the ulcer is on the pancreatic wall, the duodenum may be opened, the bleeding vessel in the floor of the ulcer underrun with a needle, and the duodenum closed. A posterior gastro-jejunostomy should be performed.

One serious haemorrhage from a gastric or duodenal ulcer is an indication for radical treatment though the patient has got well by medical means.

It has been assumed in this discussion that the bleeding is known to come from a chronic gastric or duodenal ulcer. A serious haematemesis may arise from an acute ulcer of the stomach. Surgery should not be done for this; the ulcer is a mucous one, invisible from the outside of the stomach and very difficult to find even when the viscus has been opened on the operating table. This fact makes the decision whether to employ surgery or not more difficult still in the face of a severe haematemesis when there is no certain knowledge of the existence of a chronic lesion. The history is of great importance in these cases and the fact that acute ulcers occur more often in young people, whilst chronic ulcers occur later in life.

Hour-Glass Stomach

This is a condition in which the stomach is bilocular. The two pouches are of unequal size, the proximal one being the larger. The disease is said to be the result of the cicatrisation of an ulcer which has extended down on each side from the lesser curvature. But, if this is so, it is rather extraordinary that hour-glass stomach is much more common in women than in men, whereas chronic ulcer of the stomach is much more frequent in men, in whom bilocular stomach is practically never seen. Moreover, in many cases the narrow isthmus appears to be quite supple.

The symptoms and signs are very similar to those of pyloric obstruction. The diagnosis is easily made by the X-rays. Sometimes it happens that the pylorus is constricted at the same time. The treatment of the condition is surgical. A gastro-jejunostomy into the proximal pouch will often give relief, but a partial gastrectomy is more satisfactory, and this operation must of necessity be done when there is also pyloric stenosis.

Acute Dilatation of the Stomach

A chronic dilatation of the stomach may suddenly become acute; a primary loss of tone may occur particularly after operations on the stomach in which the organ has been handled. It is also seen after other abdominal operations, in some renal affections and even after parturition. Very quickly the stomach dilates until it is quite enormous, more or less filling the peritoneal cavity. It is plainly visible on inspection of the abdomen. When the dilatation occurs in the part of the stomach left after a gastrectomy, this swelling is wanting. In the intact stomach the dilatation affects also the duodenum as far as the point where the superior mesenteric artery crosses it. The dragging of the mesentery is thought by some people to be the cause of the dilatation, the superior mesenteric artery forming a constricting band across the duodenum, but of course this explanation will not hold for those cases which occur after a partial gastrectomy. At the same time that the stomach dilates large quantities of liquid are poured into its cavity. It is got rid of by repeated vomiting. This fluid is characteristically dark brown in colour. There is tenderness of the abdomen. Great thirst is complained of. The pulse is always rapid and small in volume. If unrelieved, collapse will come on and be succeeded by death.

If the nature of the condition is recognised early, the patient's life may nearly always be saved by the introduction of a Ryle's tube into the stomach through the nose, and the repeated or continuous suction away of the contents. Gradually the tone returns to the wall of the stomach, the amount of liquid it is possible to aspirate diminishes and it loses its brown colour. The tube should not be removed until it is quite certain that the dilatation has ceased, though it may have to remain for as long as 5 or 6 days.

Hypertrophic Stenosis of the Pylorus

The patient is as a rule a healthy male infant. There appears to be no gastric disturbance until the second or third week of life. Then the child begins to vomit. The vomiting becomes more frequent and finally forcible. Food unmixed with bile is alone brought up. There is the most severe constipation and the child soon wastes. Visible peristaltic waves in the epigastrium are characteristic, and a hard tumour like a rounded nut can be felt under the margin of the liver in the right hypochondrium. Some of these babies die within a few weeks, some live for months, others gradually recover and become healthy.

All these children, if they are not too emaciated, should at first have medical treatment. The stomach is washed out every morning. Twenty minutes before each two-hourly feed 1-2 c.c. of 1 in 1000 eumydrin solution is given. It is claimed that by these means many cures are brought about. But there are also a number of failures and then surgery is indicated, as it is in the first instance should the patient be much wasted. Before operation the stomach is washed out and 5 per cent glucose in saline solution given subcutaneously. The abdomen is opened through the upper part of the right rectus muscle. The tumour is found to be a thickened cone of the pyloric part of the stomach which stops abruptly at the pylorus itself. It is made up of hypertrophied muscle tissue. The mucous membrane is thrown into folds and the lumen is reduced to a mere chink. The tumour is brought to the surface and an incision made longitudinally along its anterior aspect, until the mucous membrane is seen to protrude (Rammstedt's operation). As the cone of hypertrophied muscle tends to invaginate into the duodenum, a recess of mucous membrane of this tube is in danger of injury unless great care is taken in making the incision. After the operation, also, much care must be taken over feeding the infant, whose intestine has not been accustomed to food and is likely to respond by diarrhoea. The operation is a very successful one.

Occasionally a similar condition is found in adults. It is supposed that such individuals have had the disease in infancy and that it has persisted. The proper treatment in adults is to resect the affected part of the stomach.

Tumours of the Stomach

They are:

Benign: (1) Adenoma.
(2) Fibromyoma.
(3) Adenomyoma

Malignant: (1) Carcinoma.
(2) Sarcoma.

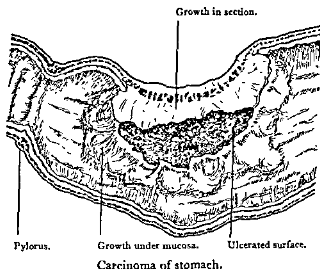
Benign Tumours

Benign tumours of the stomach are very rare. The adenomata are sessile or stalked. They grow from the body of the stomach. The other benign tumours are found mostly at the pylorus, where they may cause some pyloric obstruction. Apart from this, the symptoms of benign tumour are indigestion and either vomiting of

blood or the passage of it per rectum. A persistent melaena is characteristic. The X-ray will show a filling defect in the shadow. A partial gastrectomy is required.

Carcinoma of the Stomach

Carcinoma of the stomach is a common form of malignant disease. It attacks men much more than women, and between the ages of 40 and 60. It is spheroidal or columnar in type. Often the fibrosis makes it a scirrhus carcinoma. Sometimes the whole wall of the organ is permeated with cancer cells and fibrous tissue so that it is converted into a rigid sac (leathern-bottle stomach). The growth, to the naked eye, is either an ulcer or an irregular projection, also ulcerated. The commonest site is near the pylorus, but it may be anywhere in the stomach. If it is near the cardia it may invade the

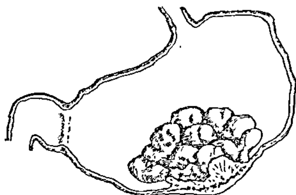


Carcinoma of stomach.

oesophagus and cause a stricture there. It does not spread to the duodenum. This is explained by the fact that the flow of lymph is from the duodenum towards the pylorus. In the stomach the lymph flows upwards and to the left to the glands along the lesser curvature, downwards and to the right to the glands along the greater curvature. Hence in any operation for the removal of a cancer of the stomach the lesser curvature must be extensively removed, whereas it is not so necessary to take away so much of the greater curvature. The lymphatic glands which may become secondarily affected are those of the lesser and greater curvatures, those around the head of the pancreas behind the first part of the duodenum, and the glands in the portal fissure of the liver. In very late cases the supraclavicular glands on the left side are found enlarged. Sometimes the cancer cells make their way along the round ligament of the liver and reach

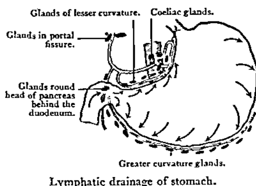
the umbilicus, where they form a hard nodule under the skin. Carried by the blood-stream they go to the liver, and they may also become detached and disseminated in the peritoneum, and particularly in the recto-vesical pouch. In this situation they may become grafted on the ovaries (Krukenberg's tumours).

Unfortunately a cancer in the body of the stomach may exist



Polypoid type of carcinoma of stomach.

for a long time without making its presence felt. The earliest symptoms are a vague indigestion and especially a distaste for food. With this a weakness and languor come on. Pain referred to the epigastrium does not seem to be affected by the taking of food. Very soon the patient becomes anaemic in appearance. When the growth is at the pylorus characteristic symptoms occur. He vomits large quantities of very foul fluid at intervals of several days. In the vomit can perhaps be seen the remains of food, such as raisin skins which have been eaten on a previous day. There is an absence of free hydrochloric acid, but in its place are found lactic and butyric acids. These acids change the haemoglobin of the blood, always present, into acid haematin, so that the gastric contents are dark brown in colour (coffee-ground vomit). Sarcinae and Oppler-Boas bacilli are present. The abdomen has a wasted appearance. Peristaltic waves running from left to right are seen; they can often be elicited by flicking the abdominal wall, or, better, by giving the patient something to eat. A hard tumour is frequently palpable. Practically always occult blood is to be demonstrated in the faeces.



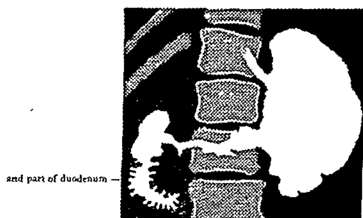
Lymphatic drainage of stomach.

The X-ray typically shows a defect in the normal shadow of the

stomach. Where the growth is infiltrating the wall of the stomach peristaltic waves do not travel. The folds of the mucosa are flattened out. In a leathern-bottle stomach the rigidity of its walls is clearly seen; the opaque meal runs right through the stomach as though it were an inert tube. When there is obstruction at the pylorus of course there is much delay in emptying. *A growth at the cardia*, constricting the oesophagus, does not allow the meal to enter the stomach, which is small and contracted. The X-ray seldom fails to reveal a carcinoma of the stomach.

About 5 to 10 per cent of simple ulcers become cancerous (ulcer cancer). In these cases there may still be free acid.

The only treatment is surgical, and the only effective treatment is



Filling defect in carcinoma of the stomach.

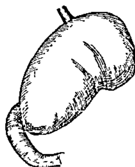
gastrectomy. But the proportion of patients in whom this operation is possible in many districts is low. This is in part due to neglect of early symptoms, but more because at first the disease is silent like cancer in other situations. The surgeon considers himself fortunate if he can remove 60 per cent of cancers of the stomach. In the operation the object should be to take away the whole of the lesser curvature with the growth; it is not necessary to remove as much of the greater curve because of the direction of the lymph-flow; a small segment only of the duodenum needs removal. All glands that it is possible to excise are taken away. However radical the operation appears to be, the number of permanent cures is low. But the relief the patient gets for the rest of his life is immense; so great that even though the surgeon cannot take away all enlarged glands, or there is a small secondary growth in the liver, gastrectomy should be done. Experience has shown that some of these patients live longer than those in whom the operation has seemed to be far more radical and complete.

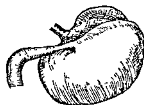
Sarcoma

Sarcoma of the stomach is very rare. The symptoms are those of a tumour of the stomach which is confirmed by the X-ray. Gastrectomy is the correct treatment.

VOLVULUS OF THE STOMACH

This is a rare condition which occurs very occasionally when the stomach is prolapsed, of which the aetiology is unknown. There are two varieties. In the one the stomach rotates round an axis which joins the cardiac and pyloric apertures. Usually the greater curvature turns forwards and upwards above the lesser curvature, the posterior surface of the stomach coming to lie anteriorly. The colon may be carried upwards with the stomach or remain below. Less commonly around the same axis the stomach rotates backwards. In the other variety the axis of rotation is vertical, the pylorus turning forwards and to the left so that again the posterior surface of the stomach looks forwards. This is sometimes called torsion of the stomach.





The two varieties of volvulus of the stomach.

The symptoms begin with acute pain in the upper abdomen and some collapse. Great distension, as in acute dilatation of the stomach, quickly appears. There is very great nausea, but of course the patient cannot vomit as both apertures of the stomach are blocked. Neither can a stomach tube be induced to enter the stomach, a fact which helps to make the diagnosis.

Operation is the only treatment. On opening the abdomen it is best to evacuate the stomach through a trocar which is not too small in calibre. Then the stomach is untwisted. Some surgeons recommend gastropexy, but it may be better to omit this and close the abdomen as quickly as possible.

CHAPTER XXVIII

DISEASES OF THE SMALL AND LARGE GUT

Injuries to the Abdomen

These are contusions and wounds.

Contusions result from percussion such as that due to a fall on to some projecting object or a blow on the abdomen; or from pressure as in a run-over accident. After such an injury shock may show itself in a few minutes, signs of haemorrhage in a few hours, or signs of peritonitis in one to two days. In nearly every case there is shock. The difficulty is, when this shock passes off, to tell whether there is an intra-abdominal lesion. A viscus is more likely to be hurt if the patient is taken unwares and his abdomen relaxed, than when he is on guard and the abdominal muscles contracted. In the latter case the brunt of the force may be expended on the abdominal wall which is bruised and contused, the organs beneath it escaping injury.

Haemorrhage may come from a rupture of the spleen or liver, from a tear of the mesentery or wall of the intestine, or, rarely, from an injury of the splenic or renal arteries. The general signs of haemorrhage have been described elsewhere (page 21): the rapid feeble low-tension pulse, the pallidity of the mucous membranes, the cold nose and ears, the sweating, the restlessness and thirst. There is some general abdominal pain, a light contraction of the muscles, and a sensation of liquid being present and tenderness in the recto-vesical pouch. Such signs require an immediate operation.

In a typical example of rupture of the intestine, from the beginning there is pain, always referred to the same place. There may be loss of liver dulness from the escape of gas from the intestine. But the pain may be slight and the general condition good. Indeed there may be very little leakage in the first six hours, partly because peristalsis is absent, and partly because everted mucous membrane blocks up the aperture; even in a complete rupture of the intestine contraction of the muscular coat of the bowel may close its lumen during the early hours. These cases are extremely deceptive, yet a quick diagnosis is

vital, for the chance of survival diminishes very greatly after the first six hours. And there is only one sign which is really reliable: it is rigidity of the abdominal muscles. They are in a spasm which becomes worse on palpation and which is absolutely constant. There is also an absence of respiratory movement. When there is this persistent spasm, although the general condition may be good, the patient feel comparatively well, and the pulse quiet, an operation should be done. An X-ray may reveal free gas in the peritoneum.

A paramedian incision to the right of the umbilicus is made. If there is blood in the peritoneal cavity an injury to the liver or spleen should first be thought of (see pages 451 and 464 for its management). The next common site for the haemorrhage is a tear in the mesentery, though a great amount of blood may come from torn intestine. A much rarer cause is a rupture of the renal artery or the splenic vessels. In both these cases there will be a large retroperitoneal haemorrhage. When the tear in the mesentery is radial in direction it is usually sufficient to tie the bleeding vessels and suture the hole in the mesentery; but when the tear runs parallel to the margin of the bowel a resection of devitalised intestine may be necessary as well. In haemorrhage from the splenic or renal arteries it is temporarily stopped by pressure against the vertebral column, whilst the blood around is removed by suction or swabbing. Then it becomes possible to find the actual severed vessel and tie it.

Tears of the intestine may be small holes, slits or amount to a complete rupture of the viscus. The small intestine is more often injured than the large, and the central coils are those usually affected by the accident as they are pressed against the bony spine. When the abdomen is opened it is often quite easy to see where the lesion is because of the presence of extravasated material; and the fact that there is a perforation of the alimentary canal is sometimes revealed by the escape of gas. Torn intestine often bleeds a great deal, so the presence of much blood in the abdomen does not exclude the existence of a perforation of the intestine. If the site of the lesion is not immediately seen, the whole alimentary tract must be searched from the duodeno-jejunal junction downwards. Holes in the gut must be sutured; if the bowel be severed right across, the two ends are sewn up and a lateral anastomosis made. It is absolutely essential that every wound of the intestine should be closed as early as possible. The prognosis gets so rapidly worse with the passage of time that it is much better in a doubtful case to operate rather than run the risk of leaving a patient until the certainty of diffuse peritonitis not only denotes the existence of a perforation but a stage beyond surgical relief.

A very serious injury is that of the posterior wall of the duodenum, for it is often not recognised until late. On exploring the abdomen there is a swelling behind the peritoneum containing blood, bile or gas. The haematoma must be opened, the tear in the viscus sewn up and a drainage tube left emerging from the loin.

Sometimes the gall-bladder or the bile-ducts are torn and biliary peritonitis results (see page 448).

That there may be an injury to the bladder must always be borne in mind in every contusion of the abdomen (see page 704).

Wounds.—In the case of gunshot and stab wounds it is of the utmost importance to determine whether the wound penetrates the abdomen or not. This can be done only by exploring it. The contused edges are cut away and layer by layer the abdominal wall inspected until the peritoneum is reached. If the missile has not gone through the peritoneum, the wound is sutured and no more done. But omentum or other viscus may protrude from the wound, or bile or faecal material escape, putting beyond doubt that penetration has occurred. The wound must be explored as before. It will probably need enlarging in order to make any examination of the injured viscus. Very likely the damaged bowel will lie immediately beneath the wound, and if a perforation can be sutured here a great deal of soiling may be avoided. On the other hand, it is very frequent for more than one intra-abdominal injury to be present, so that it is often wise to make a paramedian incision and carry out a systematic search. In the case of gunshot wounds this should always be done in addition to the exploration of the place of entry. Within the abdomen intestine may require resection or the liver or spleen be found wounded. The treatment of these lesions has already been described. A bullet may have passed through several parts of the alimentary canal.

Foreign Bodies in the Alimentary Canal

When a swallowed foreign body passes through the oesophagus into the stomach it stands a good chance of going right through the alimentary canal and being got rid of by natural means. If there are no symptoms there is no real need to take any surgical steps to remove it; but frequent examinations should be made to detect signs of perforation. Even pointed objects like pins, and indeed open safety-pins, will pass through the bowel without incident. It is sometimes recommended that porridge, wisps of cotton-wool and other cellulose-rich substances should be given to form a protection around the pointed object. This advice is an error, for such materials are likely

to lead to indigestion and increased peristalsis. Pins, fish bones and such objects may lodge in the duodenum, lower end of the ileum, in the appendix, or rectum just above the sphincters. If the X-rays show a dangerous pointed object remaining fixed in one place for more than 48 hours it should be removed; and irregular objects, although they may not be pointed, should be taken away by operation if they stay in one place for a week. Sharp objects which penetrate through the wall of the bowel or stomach give rise to symptoms of peritonitis. Fish bones impacted above the sphincter cause abscesses in the neighbourhood of the rectum.

Women and children sometimes get into the habit of biting their hair. They may swallow so much that a great accumulation occurs in the stomach, and getting matted together it forms a palpable mass which may give rise to much confusion in diagnosis unless the possibility is kept in mind. These hair balls always need removal by operation.

Intestinal Obstruction

This is a condition in which there is an interference with the onward passage of the contents of the bowel. This hindrance may be a mechanical block, or be due to a disturbance of the motor power of the intestine: a paralysis of the muscle or an occluding spasm.

There are two kinds of obstruction which it is very important to differentiate: the simple mechanical hindrance and strangulation. This latter term is given to the state of affairs when a loop of bowel passes through an aperture the margins of which constrict the two limbs of the loop; the vessels in the mesentery are compressed, the veins being closed first and then the arteries, and the circulation brought to a standstill. In simple obstruction the bowel above the block is dilated, the amount of distension in any part of the gut being greater the nearer to the obstruction it lies. Owing to the stagnation of the contents, and bacterial activity, an enteritis with ulceration is set up. This also is greatest just above the obstruction. This part of the intestine may be so damaged that it loses all power of contraction so that it is physiologically inert; though the mechanical block is removed none of the contents can be propelled along this injured part of the gut. There is much accumulation of gas, which is due only in part to the growth of the bacteria, much more to the swallowing of air. Below the block the intestine is collapsed and in spasm. In strangulation the venous return from the loop is first hindered so that blood and plasma are poured out into the wall and lumen of the bowel, and into the mesentery. The pressure soon

becomes so great within the constriction ring that the arteries are obstructed and the loop of bowel dies.

Intestinal obstruction is a very fatal disease. After it has existed for a certain time, death is almost inevitable. Yet the cause of death is not fully known. The patient goes into a state of evident toxaemia. This seems to be due to the absorption of poisons from the decomposed, stagnating contents. Whilst, at first, absorption from the obstructed bowel is less active than from the normal intestine, when the wall becomes seriously damaged, as it soon does in strangulation, and as happens later immediately above a simple obstruction, it is permeable to the products of bacterial activity. In the case of the colon there is a closed loop if the ileo-caecal valve is competent, and the tremendous distension of the caecum may damage its wall so much that poisons can get through. Depressor substances are present in the peritoneal fluid and the blood in the gut in human cases of strangulation. Release of these poisons by operation may allow them to get into the circulation and cause death.

There are other factors which play a part. Under normal circumstances a large quantity of liquid is poured into the alimentary canal; the volume of gastric, intestinal, pancreatic juices, saliva and bile amounts to as much as 7 litres in 24 hours. In obstruction more fluid than ever is secreted. Instead of this large volume of liquid being reabsorbed it is lost by vomiting. This is a very serious drain and leads to collapse. At the same time, and by the same process, the body becomes depleted of its essential chlorides owing to the gastric juice not entering the circulation again. This fluid loss is much more important when the obstruction is high, because the vomiting is greater; it scarcely comes into play in obstruction of the large intestine, where, until an advanced stage, vomiting may be absent. It has been found that the lives of obstructed animals can be greatly prolonged if normal saline is given them intravenously. Some surgeons think that Ringer's solution is more effective, but others maintain that a simple sodium chloride solution is just as good.

In strangulation the blood extravasated into the wall and lumen of the affected loop may be so much that it amounts to a dangerous loss.

From all these considerations it can be seen that, in order to save life, early operation is called for, and that it is essential to remove all gut which is physiologically inert or whose vitality is so lowered that absorption from it is likely to occur; that is, not only must the strangulated loop be removed but a considerable length of intestine above it.

Symptoms.—Intestinal obstruction clinically is divided into (1) acute obstruction, (2) chronic obstruction, and (3) chronic obstruction becoming acute.

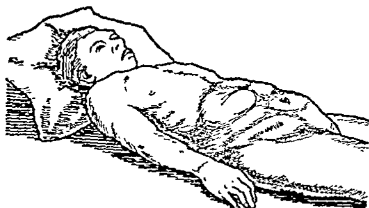
In primarily acute obstruction the most prominent symptom is pain in the abdomen not localised to any particular part. It begins suddenly and is so acute that there is usually some shock accompanying it. The pain is not continuous but occurs in spasms with intervals of relaxation. Its intensity is evident from the furrowed brow, drawn face, clenched teeth and pale, sweating skin. With the onset of the pain there is vomiting if the obstruction is in the small intestine, but very often none when the colon is the affected part. Vomiting is the more frequent the higher up the small intestine the obstruction is. What is so characteristic in obstruction of the small gut is the inability of the patient to take anything into his stomach without very quickly bringing it back. The abdomen is not rigid or tender in simple obstruction, nor is there any distension in the early stages. When there is a strangulated loop within the abdominal cavity, this very soon becomes permeable to toxins which, exuding through, irritate the peritoneum and so cause some local tenderness and rigidity. Peristalsis is not visible except in children and in multiparous women with very thin abdominal walls. A very important diagnostic point is the occurrence, with each spasm of pain, of sounds which can be heard loudly with a stethoscope; or indeed often without such aid. An enema may bring away some material from the bowel below the obstruction, but when this is empty a second enema is returned clear. In the late stages, when the bowel wall has become permeable, peritonitis comes on; the abdomen is greatly distended, there are general rigidity and tenderness, and constant effortless vomiting, the vomit becoming feculent in character. The temperature and pulse rise. The patient is so toxic that he appears to be insensitive to pain and expresses himself as much more comfortable. He is alert and quite conscious. He has reached a stage when any treatment is of no avail. Death takes place in three or four days.

In chronic obstruction the condition comes on gradually. The patient complains of indigestion; he has a fulness after meals and colicky pain; he loses his appetite. The abdomen gradually distends and peristalsis of the hypertrophied intestine may be seen through the abdominal wall. Vomiting occurs at intervals.

When chronic obstruction becomes acute there are all the signs of the acute disease accompanied by distension and visible peristalsis.

In the diagnosis of simple intestinal obstruction recurrent intestinal colic with concurrent audible borborygmi, without any other abdominal signs, make the recognition of the true nature of the condition easy. When there is strangulation the local rigidity and tenderness are apt to make confusion with a number of other intra-abdominal diseases. Radiography may be of the greatest help. In a simple skiagram of

the adult abdomen gas is seen only in the stomach and colon. When there is obstruction the stagnation of the contents in the small intestine allow the gas and fluid to separate out. If a skiagram be taken in the erect position, the gas bubbles are seen in the central coils of the small intestine lying above the liquid whose upper surface forms a horizontal line (fluid levels). Generally speaking, it is more useful to take the photograph in the supine position. Gas in the small gut is then seen



The ladder pattern of obstruction in the small intestine; only seen if the obstruction has been chronic or in emaciated individuals, children, and thin multiparous women.

in the central part of the abdomen in the form of oval bubbles with their long axes transversely arranged in a step-ladder pattern. There is often a feather appearance from the valvulae conniventes when the bowel is not too much distended. Gas in the colon is lateral in position in the form of vertically placed ovals. A simple X-ray photograph may thus give the very useful information as to whether the obstruction is in the small or large intestine. An enema should be given before the X-ray examination in order to remove gas from the bowel below the obstruction.

It has already been pointed out that vomiting is often absent in obstruction of the colon. If there is a typical picture with the X-ray but no peristalsis can be heard with a stethoscope, the obstruction is due, not to a mechanical cause, but to paralysis of the gut. In the small intestine the three commonest causes of obstruction in the order of their frequency are hernia, intussusception and adhesions. Most other acute abdominal diseases can be easily distinguished from intestinal obstruction, but sometimes they give rise to confusion. No mistake will be made if it is remembered that in these conditions there is no intestinal colic. In the crises of locomotor ataxia there is neither rigidity of the muscles nor tenderness. Diabetic coma comes on with nausea, vomiting, abdominal pain and rigidity. The flushed cheeks and the smell of acetone in the breath are distinctive.

Treatment.—As a rule it may be said that the sooner the patient

with mechanical obstruction is operated upon the better the prognosis, for, unless it is relieved before he has absorbed a fatal dose of toxin, he is doomed. There are a few cases of simple obstruction due to adhesions, such as that which occurs after appendicitis, and in which it is known that the block has a tendency to give way spontaneously, when it may be advisable to delay operation, but only with the greatest caution. Usually it will be known, if X-ray examination has been carried out, whether the obstruction is in the small or large intestine. If this is not known an incision is made below the umbilicus; the caecum is sought; if it is distended the obstruction must be in the colon; if it be collapsed the block is in the small gut above. In simple obstruction clear liquid will be found in the peritoneal cavity; when there is a strangulated loop the fluid is blood-stained. The obstruction is removed by cutting a band, separating adhesions or freeing an incarcerated loop. In the last case it must be determined whether the strangulated bowel is viable or not. The best sign of viability is a change of colour when the constricting band has been divided. If it appears that the piece of intestine will not survive it must be resected, and, as has already been said, a length of bowel above the loop must be taken away in order to remove bowel incapable of propelling its contents. Only when the condition of the patient is desperate should the two ends of the small intestine be brought out to the surface of the abdomen (enterostomy), and restoration of continuity left for a future occasion. Under these circumstances the patient frequently wastes at an extremely rapid rate so that he dies before he can be restored to normal. In any case, the second operation should be done at the end of a week. In acute obstruction of the large intestine resection and suture of the gut should never be done, as the junction is almost certain to leak and cause peritonitis; a colostomy should invariably be made above the growth, that is, an opening made in the bowel which discharges on the surface of the body. A second operation is required later, if the obstruction is removable.



Acute obstruction of small intestine.
Gas-filled coils with fluid levels.

The administration of a general anaesthetic is associated with the risk of the patient drowning in his own vomit. Yet a spinal anaesthetic

is not very desirable because it causes a further fall of blood-pressure which already is likely to be lowered.

As soon as a diagnosis has been made, morphia may be given to relieve the pain and a Ryle duodenal tube placed, through which, at frequent intervals the contents of the bowel can be aspirated. If this suction be kept up there will be no danger in administrating a general anaesthetic. After the operation it may be advisable to maintain the suction for a time. Of the greatest use is normal saline solution intravenously, given both before and after the operation.

Strangulated Hernia

Strangulated External Hernia.—This is most commonly seen in inguinal hernia simply because this variety of hernia is of more frequent occurrence. A loop of intestine passes into the sac; peristalsis then forces gas into the loop, thereby distending it so that it becomes too voluminous to return into the abdomen; at the same time this very distension drags more of the gut down. Tension rises, and at the narrow neck of the sac it becomes so great that the vessels in the mesentery are compressed, the veins first, then the arteries. The loop becomes a livid plum colour, then greenish black, and gangrene sets in. The first part of the gut to die is the constricted part of the entering limb, the next the constriction ring of the emerging limb, then the antimesenteric area at the summit of the loop. There are the usual changes in a strangulated loop, as described above.

In an inguinal hernia the site of the constriction may be either the internal or the external ring.

The chance of strangulation is greater in umbilical hernias, where the obstruction is often caused by adhesions within the sac; it is greater still in femoral hernias. In the last the hard edge of Gimbernat's ligament early leads to pressure necrosis. Direct inguinal hernias are not very prone to become strangulated; but the accident is the usual means by which attention is called to the existence of a sciatic or obturator hernia. Post-operative hernias also sometimes become strangulated.

The clinical features of strangulated hernia are the general symptoms of intestinal obstruction. As the affected loop is outside there are no signs in the abdomen. Locally an inguinal hernia becomes larger, harder, irreducible, loses its impulse, and is tender. Sometimes, however, there is no history of there having been a hernia before; the strangulation occurs when the intestine first enters the preformed sac. In a femoral hernia similar signs are present but the hernia is often of small size, and in fact may even be difficult to feel

in the groin of a fat woman. Moreover, there is a thick layer of extraperitoneal fat around the sac, and the contents are frequently omentum only.

A very serious form of hernia, because of the difficulty of making a diagnosis, is the partial enterocele or Richter's hernia. In this a portion of the circumference of the small intestine is caught in the constricting ring, the rest being free; so that the lumen of the bowel is not completely occluded. There are signs of early obstruction, though there may be the passage of some faeces, and vomiting may be absent. This kind of hernia is sometimes inguinal in type, but much more often femoral. The protrusion is so small that it is easily overlooked. A rare form of strangulated hernia is the Littré hernia, which is the incarceration of a Meckel's diverticulum.

Under certain circumstances an attempt may be made to reduce a strangulated hernia by manipulation (taxis). This should be done only when there is a history of the hernia having been reducible, when *it has only been strangulated for a short time, and then with the* utmost gentleness, because of the great risks associated with it. These are the reduction into the abdomen of non-viable gut, mechanical damage to the wall of the intestine which afterwards perforates, the forcing of infected sac fluid into the peritoneal cavity, reduction *en masse*, that is, the pushing-back of the whole sac and its contents into the abdomen without relieving the obstruction, and the reduction into another sac, which can only take place in interstitial bilocular hernias.

Whenever it is possible it is better to operate without trying taxis. By the usual incision an inguinal hernia is exposed. The sac is opened, the sign that this structure has been penetrated being the escape of the liquid within it. The constriction may be incised from within the sac or from without; the knife should be directed upward and outward to avoid the deep epigastric artery. When the omentum or intestine has been released it should be observed whether its colour is restored more to normal, for this is a sign that it is viable. It must always be pulled sufficiently far down so that the site where it was pressed upon by the constriction ring can be clearly seen, for this is the place where gangrene first takes place. It is better to resect doubtful gut than to leave it, and enterostomy should be avoided if possible (see page 367). Herniorrhaphy is then done.

The operation for strangulated femoral hernia is carried out on the same lines. The knuckle of gut is released by cutting the sharp free edge of Gimbernat's ligament. An abnormal obturator artery, if it is present, runs down behind this margin and may be divided; if it is it must be ligated after enlarging the wound. Should it be necessary to resect a piece of intestine it had better be done from

another incision through the abdominal wall above Poupart's ligament, as it is sometimes impossible to drag down enough bowel into the lower wound for easy manipulation, and after resection it may be difficult to return the intestine through the small aperture communicating with the general peritoneal cavity.

Strangulated obturator and sciatic hernias are dealt with by laparotomy; indeed they are usually not diagnosed until the abdomen has been opened.

Strangulated umbilical and ventral hernias are managed by opening the sac and dividing the constricting band, whether it is the edge of the aperture in the abdominal wall or an adhesion within the sac. In all cases the hernial aperture is closed by some plastic operation.

Strangulated Internal Hernia.—In this condition a viscus herniates through an aperture within the abdomen. The following varieties are met with: (1) diaphragmatic, (2) into the foramen of Winslow, (3) paraduodenal, (4) intersigmoid, (5) retrocaecal and (6) through a hole in the mesentery.

(1) In the case of the diaphragmatic hernia it is the colon which is usually obstructed. But as the hole through which the intestine goes is often large and its margins muscular, the contraction does not, as a rule, lead to strangulation. There are dyspnoea, pain, nausea and vomiting. In the left side of the chest, where the hernia usually is, there is abnormal resonance, and borborygmi are heard. The heart is pushed over to the other side. An X-ray will make the diagnosis clear.

The hernia is best reduced by the abdominal route. The intestine is pulled down into the abdomen and the hernial aperture sewn up, a matter of some difficulty owing to its inaccessibility. If the intestine is not viable it is resected and the two open ends of the colon brought on to the surface. Union is carried out on some future occasion.

(2) The hernia into the foramen of Winslow is very rare. The small gut passes through the aperture and fills the lesser sac. No cutting of the margins of the opening is permissible because of the portal vein in front, the vena cava behind and the hepatic artery below. The coils of intestine must be carefully pulled back into the general peritoneal cavity. If necessary the lesser sac must be opened and the coils relieved of their contained air by aspiration; then it will be possible to make the reduction.

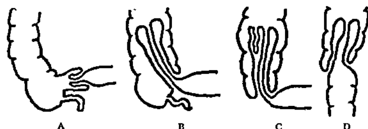
(3), (4) and (5) The paraduodenal, the intersigmoid and the retrocaecal hernias are all the result of some derangement of the development of the peritoneum, and the normal rotation of the intestine in embryo life. If, in the rotation of the small intestine, the caecal bud does not travel up to the right hypochondrium, the long length of

small intestine may be imprisoned behind in a peritoneal sac, which has an opening, either to the left or the right of the duodenum. In the former case it has the inferior mesenteric vein in the anterior margin, in the latter the superior mesenteric artery in the same situation. These two varieties are called the left and right paraduodenal hernias. Intestine may in like manner be left in pouches behind the caecum or under the mesosigmoid. These rare hernias can usually be reduced after a laparotomy. It is not usually necessary to resect the bowel.

(6) Very occasionally there is left a hole in the mesentery from imperfect development. A coil of gut may be strangulated through this. By laparotomy the intestine must be released, resected if necessary, and the hole in the mesentery sewn up.

Intussusception

This is a term given to an invagination of one part of the alimentary canal into another. There are the following varieties: (1) the enteric in which one segment of the small intestine passes into another segment, (2) the colic in which the same process takes place in the colon,



Intussusception. A. Ileal; B. Ileo-colic: the ileum has prolapsed through the ileo-caecal valve; C. Ileo-caecal: the valve forms the apex of the intussusception and the appendix is carried in with the ileum and caecum; D. Colic.

(3) the ileo-colic in which the lower end of the ileum slips through the ileo-caecal valve and enters the caecum, (4) the ileo-caecal in which the ileo-caecal valve forms the apex of the invaginated intestine within the colon.

The last two varieties are much the most common, and are met with in babies, particularly about the age when they are weaned from the breast. The cause of the condition is not known. It is supposed that the change of diet may cause irregular peristalsis. It has also been thought that large Peyer's patches acting as foreign bodies inside the bowel may lead to the invagination; but it is difficult to believe this, for the greatest enlargement of the lymphoid tissues takes place

another incision through the abdominal wall above Poupart's ligament, as it is sometimes impossible to drag down enough bowel into the lower wound for easy manipulation, and after resection it may be difficult to return the intestine through the small aperture communicating with the general peritoneal cavity.

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whilst in the period of relaxation it may be so soft that it cannot be felt. The tumour moves along the course of the colon and may ultimately reach the rectum, where it may be felt with the finger. It may sometimes actually protrude from the anus.

There is usually no difficulty in the diagnosis. In enteritis there are pain, vomiting and the passage of blood and mucus; but there is faecal material in the ejecta for there is no intestinal obstruction. The same may be said of Henoch's purpura, which in addition shows haemorrhages in the skin. In doubtful cases a small barium enema may be given; this will be brought up against the end of the intussusceptum and sometimes an air-containing coil of gut can be demonstrated within the intussuscipiens.



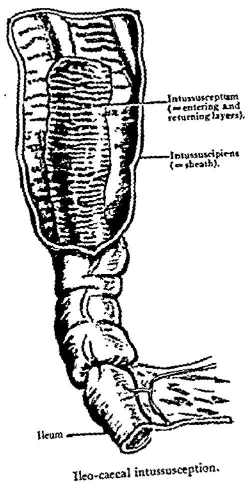
Barium enema in intussusception.

Without delay an acute intussusception should be operated upon. The incision is best made just to the right of the middle line below the umbilicus. It is very useful to let saline solution flow into the rectum during the operation, the container being about 2 feet above the table. This immensely facilitates the reduction of the greater part of the invagination, which is done by manipulation with the fingers within the abdomen. The last part of the intussusception must be withdrawn on to the surface and the reduction completed. In a late case it may be impossible to reduce the whole of the invagination because the adhesions between the entering and returning layers are too firm. Vigorous attempts at pulling the gut out are likely to tear it. The gut may be resected and the two ends sutured, or perhaps brought on to the surface and left to discharge there. Both these procedures are followed by a very high death rate. There are two reasons for this: in the first place, an intussusception only becomes irreducible after it has existed for a long time, so that the patient has passed into the fatal toxic stage of intestinal obstruction in which no treatment can bring about a happy issue; in the second, the infant has not developed its tissue immunity, and, as there must necessarily be some infection at the operation, it succumbs to peritonitis.

There are reports of successful reductions by the use of enemata alone. This method should be tried only when it can be done under

about 11 years of age, not at the time when intussusception is most common. In the small intestine and colon, and in general in older patients, an intussusception is dependent on the presence of a tumour of the bowel or a Meckel's diverticulum.

An intussusception is composed of three layers: the entering layer, the returning layer and the sheath. The opposing walls of the entering and returning layers are covered with peritoneum and therefore very prone to adhere together, which in fact they do. It is thus that they have come to be regarded as one structure, the intussusceptum; with this nomenclature the sheath is called the intussuscipiens. As the one part of the intestine is dragged into the other the mesentery is taken with it, and very soon its vessels are compressed. This results in the invaginated part becoming swollen. Blood is not only extravasated into the intussusceptum, it is also poured into the lumen of the bowel and passed from the rectum. In time the pressure on the vessels becomes so great that gangrene of the intussusceptum occurs, and the oedema is so great that there is intestinal obstruction. The ileo-caecal form is the commonest variety; of course, it can occur only when there is a persistent mesocolon to the ascending colon. The apex of the intussusception is formed by the ileo-caecal valve, and the appendix is the last structure to appear on reduction. When there is no mesocolon the intussusception is of the ileo-colic type.

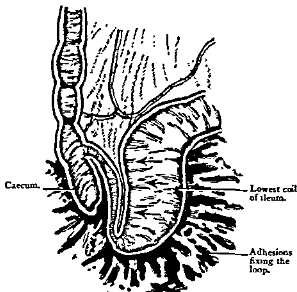


Ileo-caecal intussusception.

As a rule it is a healthy baby that is suddenly attacked by pain in the abdomen. It cries out and draws up its knees and vomits. In a short time the pain passes off; the child becomes quiet. These painful colics come on at intervals. Soon there is the passage of blood and mucus from the anus. If the abdomen be examined there will characteristically be found a tumour shaped like a sausage with its concavity facing towards the centre of the abdomen. This tumour varies in consistency: it becomes hard when the colic occurs;

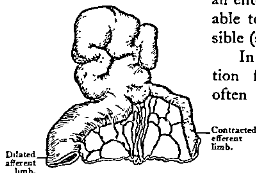
intestine may become adherent to itself, as shown in the lower figure on this page.

In obstruction by bands it is usually quite simple to divide the band and free the gut. Resection may be necessary if there be strangulation. When there has been recently an acute abdominal attack, such as appendicitis with a septic wound, the problem is not so simple. There is a risk of disseminating the infection in the abdomen if the original wound is opened. Yet, on the whole, this is the best procedure; the surgeon frees the loop and relies upon the immunity of the patient, which is likely to be high under these circumstances. An alternative method is to open the abdomen through a fresh place, the middle line, and join a low loop of the ileum to the transverse colon. A third way is to perform an enterostomy, but it is always advisable to avoid such an opening if possible (see page 367).



Obstruction after appendicitis. Fixation of the lowest loop. The thrusting over of adjacent walls like a valve.

In the obstruction after an operation for appendicitis, which is so often due to an adherent loop, there is quite a considerable chance of the obstruction being relieved spontaneously with the passage of time. It is justifiable to pass a duodenal tube and employ constant suction and to give enemata, provided a careful watch is kept on the general condition. An operation may in this way be avoided.



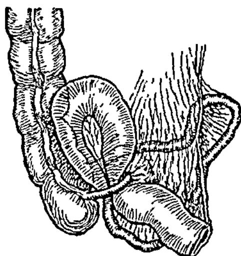
A matted coil of small intestine found in a ventral hernia which caused obstruction.

X-ray observation, so that it can be actually seen that the barium can pass backwards into the small intestine, thus demonstrating that the reduction is complete.

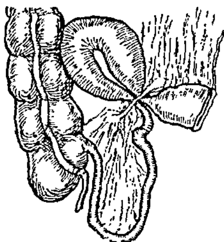
Occasionally an intussusception will recur. If it does, the abdomen must be opened again. It is not necessary as a rule to suture the caecum to the iliac fossa.

Obstruction by Bands and Adhesions

A band, to cause obstruction, must be fixed at its two ends in order to produce either simple obstruction or strangulation. Normal



Strangulation under a band formed by the appendix adherent by its tip to the mesentery.



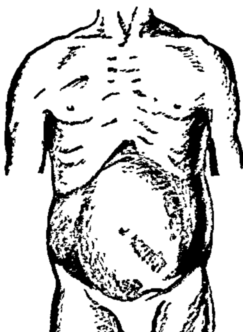
Strangulation under a band resulting from inflammation around a mesenteric gland.

structures, if they become inflamed and fixed, such as the omentum, or appendix, or Fallopian tube, or Meckel's diverticulum, or an appendix epiploica, may all act in this way. New bands formed by the stretching of adhesions, however, are the commonest variety of band. Thus, with this form of obstruction, there is a history of an inflammatory attack within the abdomen, or an operation.

Adhesions also give rise to obstruction by matting and fixation. Within two weeks of an attack of acute appendicitis, especially when a drainage tube has been left in the wound, there may occur a crisis of acute recurring pain in the abdomen accompanied by vomiting. The lowest coil of small intestine is usually the obstructed loop. It is fixed by adhesions to the surrounding parts, so that when a peristaltic wave arrives it is unable to straighten out to allow of the passage of the intestinal contents; the opposed walls of the two limbs of the loop are pushed over like a valve. In other cases a coil of

vitality, it should be excised and the two ends brought out on to the surface of the abdomen.

In ileal volvulus the bowel is untwisted; if necessary it must be resected and an anastomosis done. The same procedure is carried out in ileo-caecal volvulus.



An enormously distended sigmoid loop, the result of a sigmoid volvulus.

Obstruction due to Tumours of the Bowel Wall and to Strictures

In the small intestine obstruction may be due to a lipoma, myoma, fibroma, adenoma, angioma or an enterogenous cyst. All these tumours are rare, as is a carcinoma in the small intestine. Simple fibrous strictures result from mechanical damage to the wall of the intestine, from a small thrombosis in the mesentery, or cicatrisation in the constriction ring of a strangulated hernia which has been reduced by taxis, or otherwise. After resection of a segment of the small intestine with end-to-end anastomosis a fibrous stricture may also occur. Regional ileitis is another cause of obstruction. Tuberculous ulcers in the small gut heal with the formation of a fibrous stricture; such narrowing is apt to occur in more than one place.

In the large intestine carcinoma is the commonest cause of obstruction; less often it is due to diverticulitis and less often still to multiple adenomata.

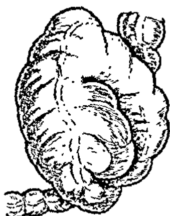
These conditions in the large intestine are considered elsewhere (page 389). When obstruction is due to a tumour of the small intestine the growth should be excised and the continuity of the bowel restored by anastomosis. The obstruction may be due to an intussusception of the tumour. The narrow fibrous strictures are best treated by short-circuit. Regional ileitis is described on page 381.

Obstruction due to compression of the Bowel

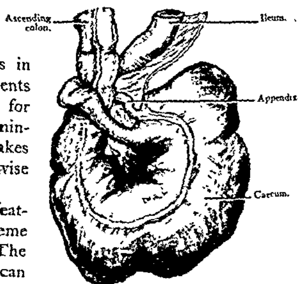
Cysts and solid tumours of the mesentery, hydronephrosis, and tumours of the kidney are the conditions which have been known to cause obstruction from compression. The primary lesion is usually

Volvulus

In volvulus a loop of intestine twists round an axis which runs from the root of the mesentery to the summit of the loop. It occurs more easily when the limbs of the loop are drawn close by some inflammation in this situation. In the case of the sigmoid loop, which most commonly becomes twisted, the inflammation is in the lymphatic glands which lie at the root of the mesosigmoid secondary to colitis in the loop; in the case of a loop of small intestine it is contraction of the mesentery around a tuberculous gland which draws the limbs of the loop together.


Volvulus of the sigmoid.

Volvulus occurs most frequently in the sigmoid colon, in the small intestine as just mentioned, or in a hernial sac where the limbs of the loop are close together because of the narrow opening into the sac. Ileo-caecal volvulus also occurs in which both sigmoid and ileum take part.



Volvulus of the caecum and ileum.

Sigmoid volvulus occurs in late middle age, and in patients who have been constipated for years. They have very voluminous colons. The rotation takes place usually in the clockwise direction.

The outstanding clinical feature is the rapid and extreme distension of the abdomen. The enormously dilated sigmoid can often be seen to stand out through the abdominal walls. The twisting of the loop obstructs the supplying vessels. There is thus caused a haemorrhagic exudation into the lumen, walls and peritoneal cavity. The loop loses its vitality. In consequence the abdomen is rigid and tender. By laparotomy the loop can often be untwisted, though it may be necessary to let out the contained air through a hollow needle before this can be done; but this operation is frequently unsatisfactory, as the volvulus recurs. When the bowel is damaged to the point that it seems unlikely to maintain its

Obturation by Foreign Bodies

Obturation by foreign bodies, such as those swallowed by children, or by an enterolith, or even by a mass of ascarides is occasionally met with. An enterolith is composed of an outer shell of calcium phosphate and calcium carbonate deposited around a collection of indigestible material such as the husks of grain.

Adynamic Obstruction

This is also called inhibition ileus, or paralytic ileus. It is due essentially to overaction of the sympathetic nerves, for it has been shown that a spinal anaesthetic will sometimes cause the bowel to act in this condition. It occurs in peritonitis most commonly, but also reflexly after injuries to the abdomen and especially to the kidney, in renal colic, in torsions of the ovary or spermatic cord.

The outstanding feature is the abdominal distension. There is little or no pain, and no noises are heard with the stethoscope. When it is due to peritonitis the abdomen is tender. Very little urine is passed, and if the patient is given fluids he is likely to become oedematous. Vomiting is not a prominent symptom.

The condition is difficult to treat. Warmth to the abdomen by electric lamps slung from a cradle helps to promote peristalsis. The immobilisation of the intestine is probably in part protective to prevent the spread of the infective process within the peritoneal cavity. From this point of view the administration of morphine is good. On the other hand, the great distension is itself a menace. The passage of a duodenal tube and suction will relieve this without disturbing the intestine too much. It is very probably a better method than such drugs as acetyl choline 0·1 gm. hourly for 6 doses, or enemata, which are often ineffective.

Enterostomy has been used a good deal. It fails because it does not drain any considerable length of the intestine; in fact it only seems to act when the paralysis passes off. In the ileus due to injury or torsions the correction of the primary lesion leads to the disappearance of the bowel inhibition.

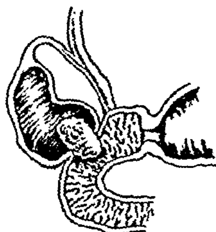
Dynamic Obstruction

Dynamic obstruction or spastic ileus is a rare condition. It has been seen in the small intestine in lead poisoning, but is more common

easily recognised and must be dealt with. Suction with a duodenal tube may tide the patient over the acute crisis.

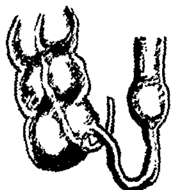
Congenital Atresia

A defect in the growth of the intestine is most commonly seen in the lower end of the ileum. Much less often it occurs in the duodenum or colon. Imperforate anus, considered on page 418, is more common. The degree of obstruction may be quite slight or amount to an absolute interruption of the bowel, a cord of solid tissue alone representing it.



The severity of the symptoms depends upon the degree of constriction, but in any case the illness brooks of no delay. The outlook is poor. Successful results have been obtained from a lateral anastomosis, never from an enterostomy.

Obstruction by Gall-stones



Obstruction by gall-stone. It enters the duodenum by a fistula between this part of the alimentary canal and the gall-bladder; it lodges usually in the narrow lower ileum.

This occurs in elderly people. There is an attack of pain in the right hypochondrium, with vomiting and fever, which is due to acute cholecystitis. The gall-bladder becomes adherent to the duodenum; ulceration follows and a communication is formed between the gall-bladder and the bowel which allows a gall-stone of such a size to pass through that it is able to cause intestinal obstruction in the small bowel, usually in the ileum where the calibre is least. Only very rarely does the stone become impacted in the duodenum. After an interval of relief from the acute symptoms, colicky pain returns accompanied by repeated vomiting. Intestinal obstruction has occurred. The stone must be removed by laparotomy. Now and then there will be found two stones both of which may occlude the lumen of the bowel. In a small number of cases the stone has been found impacted in the large intestine.

the stomach. The clinical symptom which usually shows its presence is a haemorrhage from the rectum. The blood lost is dark in colour and intimately mixed with the faeces; but if, as sometimes happens, there is some diarrhoea the blood is bright red in hue. The patient is, as a rule, a child, but the disease is also seen in adults. Colicky pain perhaps accompanies the haemorrhage. The patient may become extremely anaemic. Intussusception, gastroenteritis, rectal polypus, leukaemia and, in adults, growths of the colon, must all be excluded. The treatment is the removal of the diverticulum.

Perforation of such an ulcer is an occasional happening. There are an acute attack of pain and all the symptoms and signs of an abdominal perforation. The diagnosis is rarely made before operation, but may be suggested by a previous unexplained haemorrhage from the bowel. At the operation the diverticulum should be removed and the perforation closed.

Peptic Ulcer of the Jejunum

Peptic ulcer of the jejunum is still rarer. Such an ulcer is not usually suspected until a perforation occurs. There have been symptoms beforehand pointing to duodenal ulcer; or, because the ulcer tends to spread around the circumference of the gut and constrict it, symptoms of subacute obstruction. Suture of the perforation or resection of the affected part of the intestine is required.

Regional Ileitis (Crohn's disease)

This is a non-specific inflammation of the jejunum, ileum or colon *which occurs in localised areas in young adults. It is sometimes* acute but is usually chronic, and associated with excessive connective tissue reaction. The commonest site is the terminal 6 to 12 inches of the ileum. In acute cases the wall of the intestine is red and swollen, the regional lymphatic glands are enlarged and the mucosa is ulcerated, especially on the mesenteric side. There is a considerable tendency to perforate into the mesentery, which then becomes greatly thickened and sometimes the seat of abscess formation. Should the abscess perforate, peritonitis is set up. In chronic cases the affected segment of the intestine becomes much thickened with connective tissue, and intestinal obstruction is caused. Perforation may take place from one of the ulcers on the mesenteric side and give rise to a fistula into an adherent area of the colon, or if an abscess has formed and has been

in the colon. Here it occurs after injuries and in neurasthenia. Clinically there is a mechanical obstruction and the nature of it is only revealed on laparotomy. The spasm is annular in type and perhaps affects more than one place. A considerable length of the bowel may be in spasm. Usually the mere handling of the intestine makes the spasm relax, and that is all that is necessary. Unfortunately the obstruction sometimes recurs. In a few cases a colostomy has been required.

Mesenteric Occlusion

This name is given to embolism of the superior mesenteric artery or to a thrombosis of the superior mesenteric vein. Embolism may affect the main artery when the whole of the small intestine becomes gangrenous, but usually the embolus lodges in one of the branches. The arteriae rectae which come off the last arcades are end arteries. Each supplies one-half of a segment of the bowel, but there is a good deal of overlapping in the area of distribution of adjacent vessels, so that more than one must be occluded in order to produce gangrene of the intestine. When the occlusion takes place proximal to the last arcade it is more difficult to see how the nutrition of the bowel is disturbed. It is suggested that the sudden occlusion causes stoppage of peristalsis and a tonic contraction of the intestinal wall which prevents the setting up of the anastomotic circulation. This may be true because the flow of blood through the last arterial arcades is sluggish and thought to be kept up largely by the peristalsis of the intestinal wall. The embolus is derived from the vegetations in heart disease. Thrombosis of the mesenteric veins is associated with some septic focus in the abdomen such as appendicitis, or with some blood disease like splenic anaemia, or with cirrhosis of the liver.

The length of gut which dies varies very much. The mesentery shows haemorrhages and oedema. There is blood-stained liquid in the peritoneum. The symptoms are those of acute obstruction, but there may be some diarrhoea and blood in the stools. There is a pronounced leucocytosis. A lump may be felt in the abdomen.

The treatment is the resection of the devitalised part of the gut with a good margin above.

Peptic Ulcer of Meckel's Diverticulum

A persistent Meckel's diverticulum occasionally has aberrant gastric mucosa in it. This is liable to ulceration like the mucosa of

right iliac fossa and the perforation closed. Though the procedure is carried out early the prognosis is bad, as the general condition of the patient is always exceedingly poor.

Tumours of the Small Intestine

Innocent tumours of the small bowel are rare. The one of most importance is the adenoma arising from an intestinal gland. There may be no symptoms, or haemorrhage may occur, or intestinal obstruction be caused, either by the great size of the adenoma or because the growth leads to an intussusception. A fibro-myoma growing from the muscular wall of the gut gives no signs until it is large enough to cause obstruction. Its mucosal surface is not ulcerated and there is no haemorrhage.

Carcinoma of the small intestine is occasionally met with. The commonest site is at the ampulla of Vater in the duodenum, where it gives rise to painless jaundice. Carcinoma of the first part of the duodenum is of extreme rarity; in the second and third parts obstruction is caused and the clinical features are those of pyloric obstruction. In the rest of the small intestine the symptoms are those of intestinal obstruction.

Growths of the small intestine should be resected if possible and an end-to-end anastomosis made. If this is impossible a short-circuit should be done.

Carcinoid or argentaffin tumours also sometimes occur in the submucous tissue of the small intestine as well as in the appendix. They probably grow from elements of the sympathetic system. These tumours are usually small but may give rise to obstruction. Twenty per cent of them cause metastasis in the lymph glands. They are therefore more malignant than similar tumours in the appendix.

Enterogenous Cysts

These are cysts which form in connection with the small intestine and whose walls are very similar in structure to the wall of the bowel: there are a double muscular layer, and submucous coat, and an epithelial lining. Cysts occur from the duodenum to the lower end of the ileum; they are situated in the muscular, submucous coats or in the mesentery. They cause symptoms of obstruction, and except when they are in the mesentery, demand a resection of a portion of the intestine.

opened, a faecal fistula may be formed on the abdominal wall. Perianal suppuration with fistula formation is also found.

The symptoms are, in acute cases, very much like those of acute appendicitis. In some cases the symptoms are those of ulcerative colitis, while in others the intermittent colic is a sign of intestinal obstruction. In acute cases there are a rise of temperature and tenderness in the right iliac fossa, where the lesion so often is. In the chronic disease with abdominal colics there are distension, loss of weight, anorexia and anaemia. A mass may be felt in the iliac fossa. The X-ray examination may be quite negative, but at other times reveals the very narrow lumen of the gut with the barium meal dammed up behind it. The ulcers on the mesenteric border show up as niches.



Skiagram of regional ileitis showing niches of ulcers on the mesenteric border of the terminal ileum.

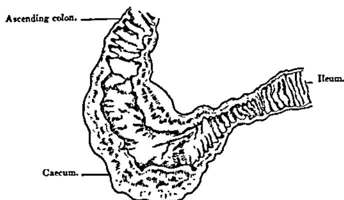
Treatment.—In acute cases when the mesentery is not involved the condition may resolve, but when the mesentery is thickened and oedematous, this is not likely to occur. Then a short-circuiting operation or a resection should be done. In chronic cases an ileocolostomy or a resection is required. Resection is also necessary when there are persistent sinuses. A simple short-circuit may not cause the lesion to disappear, so resection is always the better choice; even after this the disease sometimes appears in a previously unaffected part of the bowel.

Perforation of a Typhoid Ulcer

This serious complication occurs in the second, third or fourth week of the disease. There are sudden pain and vomiting, with a fall of temperature. There is great shock. A rapid small pulse with a falling temperature equally indicate a haemorrhage, but when there is a perforation the abdomen becomes rigid. In a few hours there will be a leucocytosis, but it is not safe to wait for this. Operation is urgently needed. The abdomen should be opened in the

the part of the large intestine to be affected. Sometimes the lower end of the ileum is also involved. The affected part of the bowel becomes converted into a solid mass.

The *symptoms* of tuberculosis of the small intestine are an indigestion, with diarrhoea and the passage of blood in the stools. The patient is pale, loses weight and is in obvious ill-health. Weeks or months pass and the pain after meals from being general becomes



Ileo-caecal tuberculosis. All the layers of the wall of the intestine are infiltrated with tuberculous granulation and fibrous tissue, causing great thickening. The ileo-caecal orifice has become rigid and the valve destroyed. The caecum is much deformed and shrunken.

localised in the right iliac fossa. It is much worse and due to obstruction. There are audible borborygmi. Sometimes the lump is palpable in the iliac fossa.

In the hyperplastic disease of the caecum there is similar indigestion pain referred to the right iliac fossa, and sometimes diarrhoea. Soon a very obvious tumour appears in the fossa. X-rays are a help in revealing the encroachment on the lumen of the bowel.

The treatment of primary tuberculosis of the intestine is surgical and operative. In the small intestine it is best whenever possible to resect the diseased bowel and perform an anastomosis. When from the extent of the growth or its adhesions this is not possible, then a short-circuit operation must be done in its place. In hyperplastic tuberculosis of the caecum it may likewise be possible to resect the whole caecum and the lower end of the ileum, making an anastomosis with the ascending or transverse colon. This is much the best treatment, for the prognosis when a simple short-circuit is done is not very good.

When the bowel is affected as part of a peritoneal tuberculosis as little surgery as possible is indicated. When there is obstruction from adhesions or from a stricture of the intestine an operation is required. As a rule anastomoses are preferable to resections.

Mesenteric Cysts

A rare tumour in the abdomen is a cyst in the mesentery. Such cysts form rounded, tense tumours in the abdomen, movable, particularly from side to side. The contents are serous fluid, chyle or haemorrhagic material.

The origin of these cysts seems to vary; some are derived from remnants of the Wolffian body or the Muellerian duct; some are dermoid cysts growing from primitive genital cells which have become displaced forwards into the mesentery; others again are enterogenous cysts described above. Chyle or blood in them is probably due to the rupture of lymph- or blood-vessels in their walls.

Clinically there may be nothing but a tumour in the abdomen and the diagnosis can only be guessed. However, serious complications are liable to occur. They are two: intestinal obstruction and inflammation. The commoner is obstruction.

The best treatment is the removal of the tumour, but great care must be taken not to injure the blood-supply of the intestine. A length of bowel must oftentimes be resected in extirpating the tumour. If a cyst is so inflamed that its removal is impossible without extensively damaging the bowel, then marsupialisation is the only course. It is not very satisfactory, as a fistula may be left for many months.

Intestinal Tuberculosis

This is met with in two forms: in the one it is primarily an infection of the intestine itself; in the other the intestine shares in a tuberculous peritonitis. The distinction is important, because in the former it may be possible to eradicate the disease completely by some resection operation.

The primary disease attacks the lower end of the ileum or the caecum. In the small intestine it appears that the Peyer's patches are the first to be infected. In the appendix, again, it is the lymphoid tissue in which the disease begins. In the caecum and colon the bacilli apparently gain entrance through an intestinal gland. In the ulcerative variety irregular ulcers form which have a tendency in the small gut to spread round it transversely. When such ulcers heal they give rise to annular strictures. More than one stricture in the lower ileum is often present. In the hyperplastic variety there is not so much ulceration as a great formation of granulation tissue, particularly in the submucous and subserous coats. Outside, immediately beneath the peritoneum, fat is deposited. The caecum is usually

it progresses upwards from the rectum to the caecum, and the whole of the colon is affected. Very seldom is it confined to one segment of the colon. Severe haemorrhage from the bowel is common. Metastatic infections of the joints are unfortunate complications.

No operation should ever be done for this serious disease until all the resources of medicine have been exhausted. The possible exception to this rule is appendicostomy for the purpose of washing out the colon. Much, however, cannot be hoped for from this procedure.

In desperate cases an ileostomy puts the whole colon at rest. Immediately there is a great improvement in the patient's general condition. There are difficulties in the nursing of such patients as the contents of the ileum are very irritating to the skin, which must be protected with ointments and kaolin powder. Of ointments, the following has been found useful: powdered aluminium 1 part, zinc oxide 1 part, liquid paraffin 2 parts. In favourable instances the disease recovers sufficiently for the artificial anus to be closed in three months' time. As the operation is done only in very severe cases it has a high mortality. Sometimes the ileostomy is left as a permanent anus, the whole of the colon being excised. There is a very small place for this operation. The plight of a patient without a colon is apt to be one of lifelong invalidism. It is said that sometimes after the colon has been removed the ileostomy acts almost like a colostomy and with no more inconvenience.

Diverticulosis and Diverticulitis of the Colon

Diverticula of the colon are very common, particularly beyond the splenic flexure, and above all in the sigmoid. These diverticula are hernial protrusions of the mucous membrane through the muscular wall of the bowel. They are of no importance unless they become inflamed, when the condition is called diverticulitis. The disease is one of middle life or old age, and occurs particularly in stout men. There are sudden pain in the left lower abdomen, and rise of temperature, rigidity and tenderness. There may have been some chronic indigestion with dull pain on the left side for some time before. In a few days a palpable mass appears in the left iliac fossa. Just as in appendicitis, this mass may subside spontaneously or become an abscess. There is a tendency for a fistula to open into the bladder, preceded by symptoms of irritability of this viscus. Or an abscess may open into another part of the alimentary canal, or even on the skin surface.

Should the swelling from the inflammation be very great, acute

Congenital Idiopathic Dilatation of the Colon (Megacolon; Hirschsprung's Disease)

This disease is present at birth or is seen in very early life, and in boys more than in girls. The colon is greatly enlarged, lengthened and hypertrophied. The sigmoid is affected in most cases, perhaps alone, perhaps in association with the rest of the colon. The distension is so great that the haustral markings and the longitudinal bands are obliterated.

The child is obstinately constipated and its abdomen is very much distended. Though actions of the bowel so seldom take place there are none of the features of acute obstruction.

The stools are offensive. Owing to bacterial activity occasional attacks of diarrhoea may occur. So great is the distension that the lower ribs may be pushed outwards, the recti thrust apart, and the diaphragm forced upwards so as to cause dyspnoea.

When treatment by regular enemata have failed, surgical measures are indicated. Removal of the left lumbar sympathetic chain, or removal of the hypogastric plexus and the nerves around the inferior mesenteric artery, have given good results. Before doing this the patient should be given a barium enema, which of course he retains, and then a spinal anaesthetic. If under the influence of this the enema is expelled, sympathectomy is likely to be successful. However, the operation does not guard the patient against a subsequent faecal impaction, volvulus or perforation of a stercoral ulcer. Owing to the loss of sensory sympathetic impulses, coming from the bowel, these complications may develop without the patient being aware that anything is going amiss. In those cases where the dilatation stops in the lower part of the sigmoid loop the whole colon should be removed to this point and the lower ilium anastomosed to the normal remaining part of the sigmoid.

Ulcerative Colitis

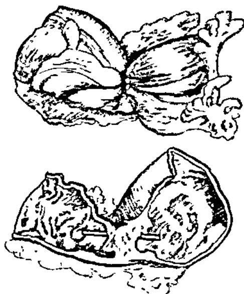
Ulcerative colitis is a disease for which operative treatment is sometimes indicated. It is a very intractable disease, due in more than 75 per cent of cases to a streptococcus. It has an acute onset with frequent bloody stools containing pus and mucus. There is a high temperature. The patient soon becomes emaciated and anaemic. Through the sigmoidoscope are seen first a hyperaemia of the mucous membrane which easily bleeds: then appear a number of miliary abscesses, which break down to form ulcers. The X-ray shows a narrowing and shortening of the colon, with loss of haustration. The disease is persistent and very difficult to treat medically. As a rule

segment of the colon involved. Here also sometimes intussusception is caused. The X-ray gives a characteristic mottled appearance due to the great number of filling defects. The danger of the disease is that nearly always one or more of the papillomata take on malignant growth, though the condition may have been known to have existed for many years before this happens.

For this serious condition it is recommended that a preliminary ileostomy be done and then the whole colon excised. This is a very severe operation and not likely to leave the patient without some further trouble. Since the disease is more often localised than general, it is possible to destroy the papillomata by fulguration. The rectum and lower sigmoid can be reached from the anus. Through a colostomy in the sigmoid colon, the upper part of this loop and the descending colon as far up as the splenic flexure can be reached with the sigmoidoscope. If necessary a transverse colostomy can be made. This method of treatment has far more to recommend it than excision of the whole of the large intestine.

Carcinoma of the Colon

Carcinoma of the colon is a fairly frequent form of malignant disease. It is met with usually between 40 and 60 years of age, though it is sometimes, like carcinoma of the rectum, found even in children. Simple polypi of the colon are thought to be the origin of a quite considerable proportion of cases. The commonest site is the sigmoid loop, then comes the caecum, and next the transverse colon. The growth is, of course, an adenocarcinoma, and it may be scirrhous or medullary. In the lower colon it takes the form of an ulcer, which has a great tendency to spread transversely around the bowel. Since it is usually scirrhous in type, it causes narrowing of the lumen and so early gives rise to obstruction. At times the growth is so linear in character that it looks almost as though a string had been tied round the gut. The other form of



The constricting form of carcinoma of the colon; from without above; from within below. The bowel looks almost as though a string had been tied round it.

obstruction may actually occur; and the resulting fibrosis may ultimately lead to chronic obstruction. There is not the same danger of an abscess rupturing into the peritoneal cavity as there is in appendicitis, so a waiting policy is amply justified. During this time *the patient must* have only liquids by mouth. Fomentations give him much relief. An abscess, when it forms, will need draining. When there is acute obstruction a colostomy, usually into the transverse colon, is necessary. Such an opening should be left for many months before exploring again with the object of resecting the affected part of the colon and restoring the continuity of the bowel. Too often it is found that, owing to extensive adhesions, resection is not possible, so that the colostomy must remain permanent. A colostomy is also required when there is a fistula into the bladder whether there is obstruction or not. Later, the fistula may be closed and perhaps a piece of colon removed.


Diverticula in the colon; several marked by a cross.

Tumours of the Colon

Adenoma.—As in the case of the small intestine, the only simple tumour at all common is the adenoma. Adenomata occur at all ages, and although as a rule one alone is present, there may be several. In size they vary from a pea to an egg. They are sessile or pedunculated. In the latter case the stalk may be very long and the tumour may give rise to an intussusception. Sessile tumours exist for a long time without symptoms; when they are pedunculated they are likely to give rise to haemorrhage and, if the tumour is large enough, to attacks of colicky pain. When situated low in the colon they can be seen with the sigmoidoscope. With the X-ray the impression of a bubble within the bowel is obtained; it must always be in the same place.

Multiple Polyposis of the colon is a familial disease which affects males more than females, and first gives rise to symptoms at 15 to 25 years. The bowel is studded with papillomata of all shapes and sizes, sessile and pedunculated. The rectum and the distal colon are the most often affected. It is only in the minority of cases that the whole large intestine is diseased. The symptoms are diarrhoea and the passage of blood and mucus. There is often pain referred to the

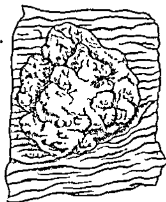
ness in the right side may be attributed to chronic appendicitis or cholecystitis. In other cases there is great weakness from profound anaemia. These patients always have the muddy complexion of septic intoxication. Occasionally the first untoward sign the patient notices is a tumour of the caecum in the right iliac fossa. Owing to the liquid nature of the contents of the caecum and the lower part of the ascending colon, and the fact that the growth is so often of the polypoid type, obstruction is not a common feature of carcinoma in this situation. However, a cancer of the caecum can encroach upon the ileo-caecal valve, when all the symptoms are those of obstruction of the small intestine.

When a growth occurs in the left half of the colon it is much more likely to be of the constricting type, and so the symptoms are those of chronic intestinal obstruction. Occasionally acute obstruction is the first sign, but this serious complication is usually grafted on a chronic obstruction. Very often the patient says he has dyspepsia, because he gets small attacks of abdominal pain after food owing to the fact that peristalsis is set up by the entry of the food into the stomach. He may also complain of wind, audible borborygmi and a feeling of distension after meals. In low growths diarrhoea is apt to alternate with constipation, being caused by the activity of bacteria liquefying the contents of the bowel above the stricture, thus allowing of their passage. Blood appears in the faeces and is bright red in colour. The tumour can often be felt, but again the constricting ring may be much too small to be palpable through the abdominal wall. Of course faeces are held up above the growth and they may form a palpable lump. The disappearance of such a tumour after an aperient or an enema must not be taken to mean that there is no cancer present. The abdomen is distended and the swelling is particularly in the flanks. If the chronic obstruction has lasted for a long time so that there has occurred a hypertrophy of the bowel, peristalsis may actually be seen. A fixed growth may perforate and cause an abscess on the left side of the abdomen, and sometimes a stercoral ulcer of the colon above the obstruction gives way and leads to diffuse peritonitis.



Carcinoma of splenic flexure.

carcinoma in the colon is a soft fungating mass which projects into the cavity of the bowel. Though this is found on the left side it is more common on the right. Only when it becomes very large does such a growth produce obstruction. On the other hand, it has a tendency to burrow outwards into the surrounding parts and cause an abscess. In this way a fistula into another part of the bowel or into the stomach may occur, or diffuse peritonitis. It is not extremely rare for two, or even more, carcinomata of about equal size to be present in the colon at the same time; whether they are examples of multiple primary growths or are implantations is not certain.



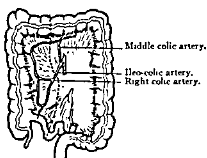
Proliferating or cauliflower type of carcinoma of colon.

Along the colon close to its attached border are small lymphatic glands, the epicolic glands. These glands are the first to be infected with malignant cells. From them the lymph goes to glands situated along the main colic vessels, namely, the ileo-colic, middle, right and left colic arteries and the inferior mesenteric. The main glands are close to the points of origin of these vessels. The lymphatic glands are very numerous, and this seems to be an important factor in the prevention of widespread dissemination of the disease, so that the prognosis in cancer of the colon is better than in many other parts of the body. Metastasis occurs also by the blood-stream, by which the growth reaches the liver. An important point to remember in operating upon the colon for cancer is that enlarged glands may contain no cancer cells but owe their increase in size to septic infection. A severe colitis occurs above a constricting growth, and perhaps ulceration, which may lead to perforation.

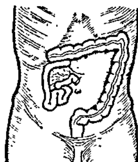
In the early stages of the disease the symptoms are very vague or absent. At most there is some slight change in the habit of the bowel, an increasing constipation or perhaps a little diarrhoea. The two halves of the colon differ very much in function. The right half up to the middle of the transverse colon is developed from the mid-gut and is concerned with digestion and absorption. The left half, derived from the hind-gut, is a mere storage organ. Hence the clinical features of the disease differ somewhat with the situation of the growth.

In the right half of the colon the large soft ulcerating growth is liable to cause a considerable loss of blood and to become very septic, so that severe intoxication from absorption results. At first there is only a slight change in the habit of the bowels, perhaps alternating periods of diarrhoea and constipation. Pain and local tender-

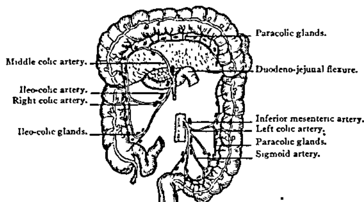
ends together side by side like the barrels of a gun and leave them open on the surface of the abdomen. This avoids all danger of



Line of section when the growth is in the caecum ascending colon or hepatic flexure.

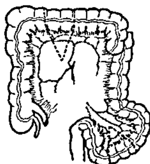


The anastomosis of the ileum to the transverse colon.



Arteries and lymphatic glands of colon.

leakage from a primary resection with anastomosis and gets rid of the growth at the earliest possible time. In order to close the fistula a clamp is put tightly on the spur between the two limbs of colon, and left. A communication is thus made between the two limbs below the surface of the abdominal wall. The faeces pass on their normal way and the external opening can then be closed. Sometimes it actually heals by itself. This operation was devised by Paul, a Liverpool surgeon, though it often goes under the name of Mickulicz. In order to protect as far as possible the abdominal wall from soiling, an angled glass tube is tied in the open end of each piece of colon at the first operation (Paul's tubes). Paul's operation is an exceedingly safe one and has the advantage



Lines of section when the growth is in the transverse colon or sigmoid flexure.

The barium enema reveals a filling defect in the outline of the shadow of the colon. X-rays are a very reliable method of diagnosis, but it must be remembered that within the pelvis a stricture may be concealed by the shadow of a coil of healthy gut lying in front of it. When the growth is low, sigmoidoscopy is a certain means of diagnosis.



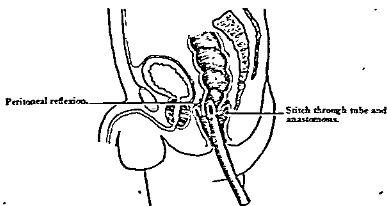
Carcinoma of the pelvic colon.

The *treatment* of this condition is operative. Either the growth is removed or, if that is impossible, a short-circuit operation is performed. There are certain things that must be borne in mind. When there is obstruction present of any degree but the slightest no resection with suture of the bowel must ever be done, for experience has shown that a leak is almost certain to occur. Therefore under such circumstances the bowel should be opened above the growth to relieve the obstruction first. In two or three weeks the general condition of the patient will be immensely improved and the growth can be excised. The faecal fistula on the surface of the body is closed at some subsequent date. When the growth is irremovable or there are extensive secondary growths in the liver, the obstruction should be short-circuited by an anastomosis.

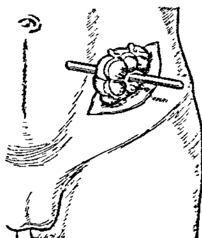
On the right side of the body it is often possible with impunity to resect the growth at the first operation, partly because the contents of the bowel are liquid, and also because it is the small intestine with which the junction has to be made. Thus in carcinoma of the caecum the ileum is cut across about 5 inches from its lower end; the distal part of the ileum, the ascending and one-third of the transverse colon are removed. The open end of the colon is closed and the end of the ileum implanted into the side of the transverse colon. The same operation is done for any growth in the ascending colon or hepatic flexure. The reason for taking away so much bowel is that the important lymphatic glands lie at the root of the ileo-colic artery. If this vessel is tied and the right colic artery comes off it, as it so often does, the vitality of the ascending colon is endangered. Hence the necessity for removing it.

In the transverse colon and the sigmoid a much more restricted resection proves to be effective. The growth with 3 or 4 cm. of bowel on either side and a V-shaped portion of the mesentery are cut away. An excellent method of completing the operation is to suture the two

Or sometimes, with a short sigmoid loop, the upper end must



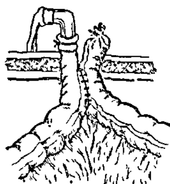
Excision of a growth just above the peritoneal floor. Invagination is produced by pulling on a rectal tube stitched to the anastomatic line.

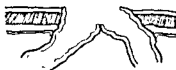


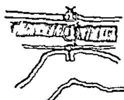
In performing an iliac colostomy a glass rod is passed through a hole in the mesosigmoid to prevent the bowel from slipping back into the abdomen.

be brought to the surface to form a permanent colostomy, whilst the open lower end is closed by suture.

of getting rid of the growth at once. The alternative is to perform a caecostomy to relieve obstruction at the first operation, and at the second to remove the growth and restore the continuity of the bowel

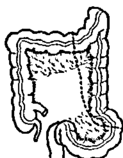

Paul's operation. The growth has been removed. A Paul's tube has been tied in the upper end; the lower end is ligated.

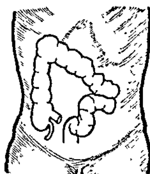

Paul's operation. The spur has been destroyed by leaving on it a tightened clamp.


Paul's operation. The continuity of the bowel has been restored.

by suture. The caecostomy will often heal by itself. Instead of a caecostomy an opening in the transverse colon may be made when the growth is in the sigmoid. *It is more effective than a caecostomy* in emptying the bowel.

Growths which are very low down in the colon and which cannot be brought to the surface for a Paul's operation present some difficulty. One useful method is, after resecting the growth, to cause an


Line of section when *the growth is at the* splenic flexure or descending colon.


The anastomosis of the *transverse colon* to the sigmoid flexure.

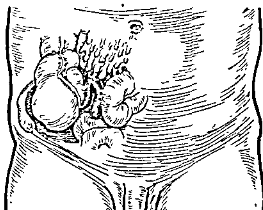
intussusception of the upper end into the lower by passing a tube up the rectum and suturing it to the upper cut end. By dragging on the tube the invagination is produced. The junction is then made secure by suturing it all round.

Anatomically the appendix may lie in one of several positions, and the results of inflammation depend to some extent upon its situation. The organ may point upwards and to the left behind the mesentery towards the spleen; or upwards behind the caecum in a retro-caecal fossa; or upwards along the outer side of the ascending colon, where it may have a very imperfect investment with peritoneum, and in fact be almost extraperitoneal in position; or the caecum may hang over the pelvis and the appendix be quite within the pelvic cavity.

The following forms of appendicitis are recognised:

(1) Catarrhal appendicitis is the form where the infection is confined to the wall of the appendix and resolves, leaving perhaps a stricture as has been already mentioned, a narrowing which may lead to another attack.

(2) In appendicitis with plastic peritonitis the inflammation reaches the peritoneal surface and causes neighbouring structures to become matted to the appendix. The resulting mass is composed of the thickened appendix itself, caecum, omentum and coils of small intestine fused together.



Appendicitis. Diagram to show how the appendix, omentum, caecum and coils of small intestine become fused together to form the mass in the right iliac fossa.

(3) In appendicitis with abscess the inflammation progresses to the further stage of pus formation in the midst of these matted structures. Such an abscess may actually be absorbed and the whole process resolve. Or, if the immunity of the patient is not equal to combating the attack, the abscess will spread. Most frequently the pus makes its way into the general peritoneal cavity, a very serious complication, as the body then has to deal with a diffuse peritonitis when its defences are weak. Sometimes the pus finds its way into the rectum or into the ascending colon with a much happier outcome. The formation of the abscess is often preceded by gangrene of a small area or of the whole of the appendix and perforation. Gangrene of the appendix is a very common phenomenon; it occurs so easily because the nutrition of the appendix depends solely upon the small artery which runs along the free border of the meso-appendix; and this is liable to become thrombosed as the inflammation of the appendix spreads to its mesentery. Local pressure seems to have

CHAPTER XXIX

APPENDICITIS

Although appendicitis is such a common disease the causes which bring it into being are not very clearly known. It is a primary infection of the lymphoid follicles in the wall of the appendix, and just as infections of lymphatic tissue in other parts of the body are more common in young people, so appendicitis is a disease of young individuals, especially males. Only about 1 per cent of cases occur in children under 5 years of age, and it is rather rare in the aged. Infection comes from the lumen of the appendix. It is true that it sometimes occurs in association with a streptococcal sore throat, and a blood-stream origin has been postulated because of this; but an equally good explanation is that the organisms are swallowed and reach the cavity of the appendix. The contents of the lower end of the ileum, the caecum and the appendix have a relatively larger number of bacteria than any other part of the alimentary canal. Towards the tip of the appendix enterococci and haemolytic streptococci normally preponderate, and it is here that the inflammation usually begins. At first it seems to be due to streptococci, but very soon the *Bacillus coli* and other organisms such as the *Bacillus pyocyaneus* and anaerobic bacilli appear and grow luxuriantly. Infection seems to be predisposed to by anything which causes stagnation of the contents of the appendix. Swelling of the lymphoid follicles may do this in the first attack, or a particularly well-developed fold of Gerlach, or a short meso-appendix which causes twisting or torsion of the appendix. There have often been some symptoms of gastro-intestinal disturbance before an attack of appendicitis comes on, suggesting that the inflammation spreads from the caecum to the appendix along the mucosa. The first attack is very likely to leave behind a little narrowing of the lumen from fibrosis; even a slight degree of stricture in such a narrow channel will favour stagnation, and so infection. It also leads to the formation of concretions called faecoliths, which thus increases the difficulty the appendix has in discharging its contents. One attack, therefore, predisposes to another.

ability of the bladder. Should the appendix lie high, almost in contact with the gall-bladder as it sometimes does, the tenderness will also be high.

Such an attack as has been described may subside; all the symptoms and signs abate in intensity and the patient return to normal. On the other hand, they may all become more strictly localised to the right iliac fossa and a lump appear there. This plastic mass again may gradually shrink and go away, or with an increasing rise of temperature become more tender: signs which declare it to be an abscess. When a mass has become well localised it is surprising how flaccid the abdominal wall around it may become. The rupture of an abscess into the general peritoneal cavity causes severe abdominal pain, widespread rigidity and tenderness, a sudden increase of the pulse rate and perhaps a fall of temperature. An impending rupture into the rectum causes frequent small actions of the bowels of pure mucus. An actual discharge of the abscess into the ascending colon or the rectum leads to a rapid relief of all the symptoms.

One attack of appendicitis will usually mean another attack at some future date. In the intervals of these recurrent attacks the patient may be quite well, but sometimes suffers from mild colicky pains and has a persistent tenderness in the iliac fossa usually rather higher than McBurney's point; or he may have little attacks of pain and diarrhoea. To this state of affairs is given the term chronic appendicitis. That chronic appendicitis occurs without a previous acute attack is denied by some clinicians. It does distinctly seem to happen in cases of appendicular dyspepsia, which indeed often precedes an acute attack of appendicitis. In this there is epigastric *pain bearing some relation to food, but there is no regularity about* it. There seems to be either pyloric spasm or hypersecretion. There are nausea and flatulence, and the tenderness of chronic appendicitis to the right of the umbilicus. The dyspepsia disappears when the appendix is removed.

When the signs and symptoms are typical there is no difficulty in diagnosing appendicitis, but quite often there is some doubt. In all instances of acute abdominal disease it is primarily necessary to be able to distinguish those diseases which are medical or do not require operative treatment. Amongst medical affections diabetic coma, influenza, typhoid fever, pneumonia and hysteria must be borne in mind. Diabetic coma sometimes begins with acute pain in the abdomen and vomiting. There is no rigidity. The urine is loaded with sugar. In influenza, again, the abdominal pain, vomiting and temperature may arouse a suspicion of appendicitis but the muscular spasm is wanting. In typhoid fever the iliac fossa may be tender, but

something to do with perforation, for it so often occurs where a faecolith is situated.

(4) In appendicitis with diffuse peritonitis the intensity of the infection is so great when it reaches the surface of the organ, that there is not time for limiting adhesions to form.



Gangrenous perforated appendix with concretion.

In a typical attack of appendicitis there is often a history of some indigestion or intestinal upset for a few days previously, but many attacks begin suddenly in healthy individuals. The first sharp pain is not easily localised; it is felt vaguely in the epigastrium or behind the umbilicus. It is a continuous pain with colic-like exacerbations from time to time. After an interval the pain becomes localised to the right iliac fossa. This probably corresponds to the spread of the inflammation to the peritoneal coat. At this time there is tenderness at a spot one-third of the distance from the anterior superior spine to the umbilicus (MacBurney's point), and there is some rigidity of the muscles in the right iliac fossa. There is also hyperaesthesia of the skin in the same area. This hyperaesthesia disappears when the appendix perforates, an accident which is accompanied at the same time by greatly increased muscular spasm and more widespread tenderness. After the pain an act of vomiting occurs, though sometimes there is only nausea; the vomiting does not persist in adults though it does occasionally in children. Later still the temperature rises, but not usually to as high as 103° F. A rigor is a serious sign and denotes probably a thrombosis of the appendicular or ileo-colic vein. There is a leucocytosis of 15,000 or more. The pulse may rise only five or ten beats per minute early in the attack. It has already been said that an intestinal disturbance may precede the onset of the pain, but diarrhoea does not usually continue. It is much more common for the patient to be constipated. The sequence of the symptoms is important in diagnosis; they should be pain, nausea or vomiting, and rise of temperature in this order.

The clinical features of appendicitis are not always as regular as this. When the appendix lies within the pelvis, the tenderness may be felt only on rectal palpation, for which reason a rectal examination should always be done in suspected cases. Rigidity over the right iliac fossa may likewise be wanting, as it may also when the appendix lies to the outer side of the colon; particularly when it is more or less extraperitoneal in position. In this latter case tenderness is felt in the lumbar region. An inflamed pelvic appendix may cause irrit-

the signs that an operation is required. They also indicate that the disease is spreading and the resistance of the patient to the infection is waning—the very worst circumstances in which to undertake an operation. For this reason, although many cases under a waiting régime localise and recover, to delay operating in any case of appendicitis is bad surgery. There are two circumstances in which it is possibly allowable to refrain from operating when the patient is first seen. If the disease has lasted for some days and the subjective symptoms have obviously abated, and a record of the pulse and temperature shows that the infection is subsiding, and there are only mild signs in the abdomen, then it is permissible to leave the appendectomy until everything has become quiesçent. In the other extreme, when the patient is seen very late in the disease with diffuse and widespread peritonitis, it may be, on rare occasions, the wisest course not to operate at once. The only chance the patient has may be to leave him, when perhaps localisation takes place so that an abscess forms. It must be regarded as a most exceptional method and be practised only after the most careful deliberation.

When there is a mass in the right iliac fossa, operation should not be deferred. The mass must be explored, the appendix removed if possible and a collection of pus drained. Operation is urgent when there are signs of diffuse peritonitis. The appendix must be removed and the abdomen drained. If the patient has had one indubitable attack of appendicitis he should be recommended to have his appendix removed to avoid another attack.

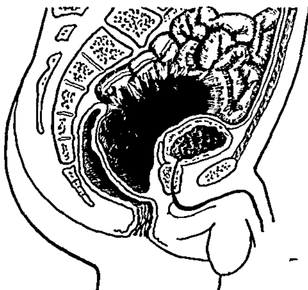
A number of incisions have been devised for the removal of the appendix. The McBurney incision, which has one-third of its length above and two-thirds below McBurney's point and is made at right angles to a line joining the anterior superior spine to the umbilicus, is very popular but has not much to recommend it. Because the successive layers of the abdominal wall, the external oblique, the internal oblique and the transversalis muscles are penetrated by splitting them in the direction of the muscle fibres, the incision is supposed to eliminate the possibility of a hernia, but this is by no means the case. Indeed by too violent retraction of the sides of the incision the ilio-inguinal nerve is sometimes bruised, the lower parts of the internal oblique and transversalis muscles paralysed and an inguinal hernia actually results. Another objection to the incision is that it cannot be conveniently enlarged should the appendix be in an inaccessible situation. A better method of approach is to make an oblique cut in the outer part of the anterior sheath of the rectus muscle; the muscle itself is then pulled inwards and the transversalis fascia and peritoneum divided behind it. The incision can easily be enlarged

the enlarged spleen, the spots and the leucopenia are characteristic. In pneumonia pain may be referred to the iliac fossa, and there may also be some muscle spasm and tenderness. This tenderness, however, is parietal; it gets less, not greater, with increase of the pressure of the palpating hand. The rigidity is not persistent; it gives way under pressure. Examination of the chest will show the signs of a lung infection, though when the diaphragmatic pleura is involved auscultatory signs may not be present in the early stages. In all cases of doubt in suspected acute abdominal disease the greatest help is got from several examinations at short intervals. If this plan is followed some diagnostic sign is almost sure to appear. If it does not and doubt still remains, it is better to perform an exploratory laparotomy than to allow an acute abdominal condition to proceed. In hysteria the atypical grouping or sequence of the symptoms, combined with the good general condition of the patient, renders the diagnosis clear. In tabes and lead colic there is a complete absence of rigidity; in the former the want of knee-jerks and the pupillary changes, and in the latter the history and the blue gums reveal the true nature of the disease. Biliary or right-sided renal colic characteristically ends suddenly. The biliary pain is referred to the right scapula, and there is no real rigidity unless the inflammation of the gall-bladder has spread to the peritoneal surface, whilst the maximum tenderness is in the right hypochondrium. Renal colic radiates to the testis or labium and thigh; there is oliguria or haematuria. In pyelitis the urine contains pus. The colic of colitis is unaccompanied by rigidity. Torsion of an ovarian cyst on the right side can usually be recognised by the large central tumour in the abdomen. If the cyst be small it may lie within the pelvis and be impalpable. Haemorrhage into an ovarian follicle or a small haemorrhage from an ectopic gestation may similarly give rise to confusion, which may be resolved only on the laparotomy.

The treatment of appendicitis is nearly always surgical. Within 48 hours the appendix has not usually perforated, so that there is not any widespread peritoneal infection and the appendix is free. If it is removed during this period there is no need to drain the abdomen; the disease is cut short and the patient quickly gets well.

When the patient is seen in a later stage, with perhaps a mass in the iliac fossa, some surgeons recommend that a waiting policy should be adopted. The patient is kept without food; a little water only is allowed by mouth. He may be given rectal saline and hot applications to the abdomen. An hourly pulse is taken and the condition of the abdomen observed at frequent intervals. An increase in the area of tenderness, a more rapid pulse and a rise of temperature are

rarest occasions when there may be a single abscess which, on being opened, is followed by a cure. As a rule, portal pyaemia is a fatal



Large pelvic abscess pushing down the recto-vesical pouch and the anterior wall of the rectum from whose cavity it can be evacuated.

disease. A rise of temperature is also caused by femoral thrombosis, and, particularly in female children, by a *Bacillus coli* pyelitis. Intestinal obstruction is sometimes seen (page 374).

Tuberculous Appendicitis

Tuberculous appendicitis is rare. The organ is much thickened and may show tubercles on its peritoneal surface. The tuberculous process may allow a secondary infection to supervene, so that there is an acute attack. The disease may not be recognised as tuberculous until the wound in the abdomen fails to heal. There is likely to be a sinus for a very long time.

Actinomycosis of the Appendix

Actinomycosis of the appendix, by leading to abscess formation, is similarly apt to be missed at first. In this case not only does a sinus persist but the surrounding tissues become hard and indurated. This is what arouses suspicion and the diagnosis is confirmed by finding the sulphur granules in the pus. Many cases of abdominal actinomycosis are fatal (see page 58).

obliquely upwards and outwards through the muscles beyond the rectus sheath should the appendix be found high and to the outer side of the ascending colon. The oldest incision of all, an oblique one in the right iliac fossa which cuts directly through all layers of the abdominal wall, could with advantage be more widely employed. The practice of opening the abdomen in the middle line for acute appendicitis is bad; for it is likely to introduce serious sepsis into a part of the peritoneal cavity which is unaffected. The excuse that the supposed appendicitis may turn out to be a gynaecological condition is not valid. A small incision should always be made first over the iliac fossa, when, if the diagnosis should prove wrong, it should be abandoned and another one made in the middle line. The question of drainage in acute appendicitis is important. It is not necessary in early cases, but a tube should always be left in the pelvis if there is frank pus inside the abdomen or if raw and bleeding surfaces are left after the appendix has been removed. In children it is wise to drain in the majority of cases. When, on opening the abdomen, there is a localised mass and the rest of the cavity is not infected, dissemination of the infection should be prevented as far as possible by packing off the mass with gauze, before penetrating it. Whenever circumstances allow, an appendix abscess should be opened without entering the general peritoneal cavity; it is indeed a dangerous thing to open a large abscess by the abdominal route when the free peritoneal cavity must be traversed to reach it. The appendix should always be removed at the same time if it is recognisable and can be taken away without the risk of injury to adjacent viscera. Convalescence is rendered much smoother by doing this. Pelvic abscesses are much more safely opened from the rectum when this can be done. When it has been found impossible to remove the appendix at the time that an abscess has been opened, this should be done one to two months after the abdominal wound has healed.

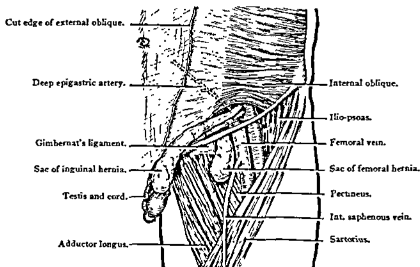
After an operation for acute appendicitis a number of complications may be met with. Accompanied by a rise of temperature, apart from local spreading of the infection within the abdomen, the commonest cause is an infection of the lung. A pelvic abscess is associated with some irritability of the bladder and rectum and the passage of stools containing almost nothing but mucus. Such an abscess should be opened from the rectum if possible, as there is considerable risk of disseminating the infection if it is opened by the abdominal route. A subphrenic abscess is more difficult to diagnose; it may be on the right or left side (see page 335). A rare complication is thrombosis of the ileo-colic vein with a portal pyaemia; this results in the formation of a number of abscesses in the liver, except on the

CHAPTER XXX

HERNIA

A HERNIA is the protrusion of a viscus through an abnormal aperture in the walls of the cavity in which it naturally lies. Thus we may speak of hernia cerebri when the brain protrudes from the skull, or a hernia of the lung when this organ protrudes from the thorax, or even a hernia of muscle which bulges through an opening in its sheath. When the term hernia is used alone it is taken to mean a projection of some viscus through a hole in the wall of the abdomen. The commonest of all hernias is that which occurs in the region of the inguinal canal.

Inguinal Hernia is either oblique or direct. In oblique or indirect hernia, the viscus passes through the internal abdominal ring, travels



Anatomy of inguinal and femoral hernia.

along the inguinal canal, and, leaving by the external abdominal ring, reaches perhaps into the scrotum or labium majus. It is covered by a prolongation of the peritoneum which is called the sac of the hernia; it receives coverings from the layers of the wall as follows: (1) internal spermatic fascia from the transversalis fascia, (2) cremas-

Tumours of the Appendix

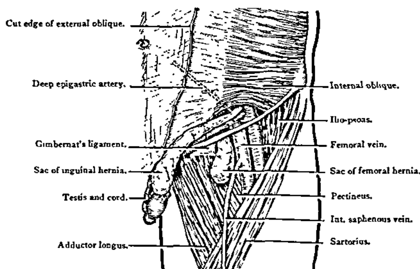
Almost the only tumour met with in the appendix is the carcinoid or *argentaffin tumour. This is locally malignant but does not form* metastases. Many patients have been cured by simple removal of the appendix. If the growth is near the base and reaches the caecum, a portion of this part of the alimentary canal as well will need taking away.

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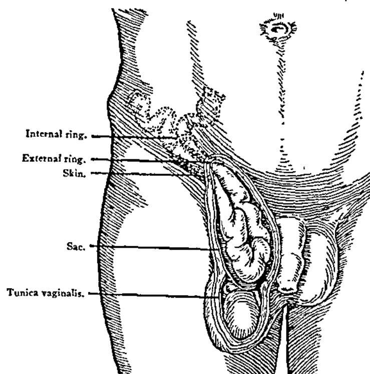


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teric fascia from the internal oblique, (3) *external spermatic* or *intercolumnar fascia* from the external oblique, (4) superficial fascia and (5) skin.

There are different *varieties of oblique inguinal hernia*: the congenital hernia is one where the sac is continuous with the tunica vaginalis; the infantile hernia is one where the processus vaginalis has been *shut off only at the internal abdominal ring*. The sac of the hernia passes down behind this structure so that in exposing the sac from in front the two layers of the processus must be cut through



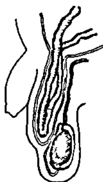
Indirect inguinal enterocele.

before the sac of the hernia is reached; sometimes the sac invaginates the processus, forming what is known as an encysted *hernia*. When the sac does *not emerge* from the inguinal canal but the hernia remains simply as a bulge in the groin it is called a bubonocele; when it reaches the scrotum or labium it is called a scrotal or labial hernia.

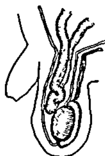
The contents of a hernia are usually intestine (enterocele) or omentum (omentocele, epiplocele), but every abdominal viscus has at some time been found in the sac of an inguinal hernia, *even the pancreas*. It is fairly common to find the appendix or the ovary and tube in a hernia, and the urinary bladder almost as often.

In many cases of *oblique inguinal hernia there is* undoubtedly a preformed sac which has been present from birth; but it is probably not true to say that there is invariably a preformed sac. The inguinal canal is a *weak spot* in the abdominal wall which is well protected

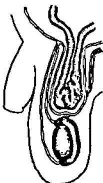
in the normal individual by a very alert reflex, the inguinal reflex. Whenever, by some sudden exertion or a cough, the pressure within the abdomen is raised, the lower parts of the internal oblique and transversalis muscles contract down flat, from their arching form, on to Poupart's ligament. Thus a layer of muscle comes down like a shutter (the inguinal shutter) and so protects the weak part of the abdominal wall in this situation. If this reflex slows up, as it does in middle life, the muscle may not come down quickly enough to prevent and counteract the strain. Under these circumstances a piece of intestine or omentum may escape through the internal ring and the beginning of a hernia has taken place. If there is a preformed sac the hernia may at once go right down into the scrotum. If only a small bulge of the peritoneum occurs, this will gradually increase in size and the hernia enlarge with the passage of time. Hernia is predisposed to by anything which causes constant straining, such as chronic constipation, calculus in the bladder, or an enlarged prostate, or by chronic bronchitis, or pregnancy which stretches the abdominal walls, or obesity which not only does this but in addition separates the muscle fibres by fat forming between them.



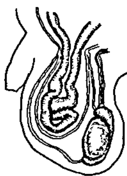
Acquired inguinal hernia.



Congenital hernia.



Infantile hernia.



Encysted hernia.

Varieties of inguinal hernia.

Inflammation may occur within the sac of a hernia; when it does so, the omentum or intestine becomes adherent to the sac walls. The hernia cannot then be replaced within the abdomen (irreducible hernia). Owing to more intestine becoming forced into the sac, or to its becoming loaded with faeces, the lumen of the gut may be obstructed (obstructed hernia). A further stage of this is when the mesentery is compressed so that the vessels are blocked; death of the contained intestine results (strangulated hernia).

A hernia is recognised by its being a protrusion through the inguinal canal, that is, by its situation, by its being reducible into the

abdominal cavity and by its having an expansile impulse on coughing. These are the three cardinal signs of a hernia. Mention has already been made that a hernia may become irreducible by the formation of adhesions; when irreducibility is complicated by strangulation it loses its impulse.

A hernia may be treated by a truss, a radical operation or by injection.

A truss is indicated when there is some strong objection to operation, heart or lung disease, diabetes, a persistent cough or other cause for constant straining, such as an enlarged prostate. In order to measure for a truss a tape is passed round the body midway between the crest of the ilium and the great trochanter at the sides, over the sacrum behind and to the crest of the pubes in front. The number of inches of this measurement is the size of the truss needed.

The operation for the radical cure of an oblique inguinal hernia is very successful, although collected statistics do not throw too favourable a light on it. An incision is made above Poupart's ligament through the external oblique, opening the inguinal canal. By separating the fibres of the cremaster muscle the sac of the hernia is found. It is isolated, opened to make sure that it is quite empty, ligatured at its neck at the internal ring and cut off. The inguinal canal is then repaired. In the original Bassini operation the lower borders of the internal oblique and transversalis muscles are sutured to Poupart's ligament. This, however, means that those fibres within the grasp of the stitches are destroyed. It is much better to preserve all the muscle possible in this situation; this can be done by sewing the upper margin of the cut in the external oblique to Poupart's ligament, and using the part below the incision for an overlap. In this way no muscle is destroyed and the anterior wall of the inguinal canal is now a double instead of a single layer of external oblique.

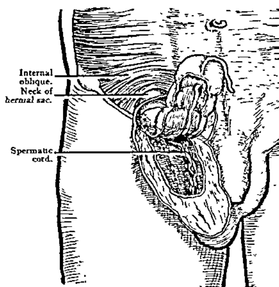
In infants the canal need not be opened; it is sufficient to pull the sac strongly through the external ring and ligate it. No repair of the canal is necessary. The operation should not as a rule be done in babies under one year. Up to this time a truss should be applied, as sometimes there is a natural obliteration of the sac.

Sometimes all the musculature of the abdomen in the inguinal region is poorly developed and there is a large space between the lower borders of the internal oblique and transversalis muscles and the inguinal ligament. In such cases it is recommended that the abdominal wall should be darned with living sutures obtained either from the fascia lata or the margin of the incision in the external oblique. This operation is seldom indicated. Certain investigations have shown that the number of recurrences is not reduced by the

method. There is a tendency for surgeons to use silk rather than catgut for the repair of hernia and some evidence that the number of permanent cures is thereby increased.

The injection treatment of hernia is a revival of an old method. The object is to cause the formation of a mass of fibrous tissue in the neighbourhood of the internal ring by the injection of an irritant solution. If this treatment is to be carried out it is essential that the hernia be completely reducible, and great care must be taken that no liquid is introduced within the sac. Moreover, during the whole *time of the treatment, the patient must not allow the hernia to come* down once. This is ensured by giving him a truss which is impervious to water and can be worn night and day. Many injection solutions have been used; the most satisfactory are solutions of gallic and tannic acids, or sylasol (sodium psylliate). The results of this treatment are not accurately known. Some reports claim a high percentage of cures, others describe a large number of recurrences. It is a long treatment, irksome to the patient and surgeon and is not much used. When it fails an operation is troublesome to perform because of the fibrosis in the cord. The method is not applicable to direct herniae.

A Sliding Hernia is one in which the caecum on the right side, or the sigmoid colon on the left, have passed down on the posterior abdominal wall carrying with them a protrusion of peritoneum, and entering the inguinal canal. The hernial aperture is always large. The sac does not completely invest the intestine; it forms a cavity lying in front and to the inner side. Unless this is borne in mind, the condition is very puzzling at operation. Such hernias are seen chiefly in middle-aged men who are rather fat. Because the sac cannot be ligated off as in the ordinary operation for hernia, and the opening into the abdomen is large, there is some difficulty in bringing about a radical cure.



Sliding hernia of caecum. Sac cut along its reflexion on to the bowel wall.

An Interstitial Hernia is sometimes seen especially in association with an incompletely descended testis. As a rule there are two sacs;

one is in the inguinal canal, the other is lying on the external oblique muscle (proparietal hernia), between the oblique muscles (interparietal hernia) or in front of the parietal peritoneum (properitoneal hernia).

Direct Inguinal Hernia is much less common and seen usually in men of middle age. The sac does not come through the internal abdominal ring but through an aperture in the transverse fascia of the space bounded by the lateral margin of the rectus muscle, the deep epigastric artery and Poupart's ligament (Hesselbach's triangle). A direct inguinal hernia therefore projects to the inner side of the deep epigastric artery, whilst the oblique form coming through the internal ring is external to this artery. The coverings are extraperitoneal fat, fascia transversalis, the conjoined tendon, the external spermatic fascia, the superficial fascia and the skin. When the hernia comes through the outer part of Hesselbach's triangle it lies outside the conjoined tendon, so instead of receiving a covering from this it is invested with the cremasteric fascia.

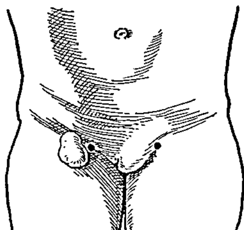
A direct hernia never passes into the scrotum. It forms a hemispherical bulge at the external ring, and when it is replaced within the abdomen it goes directly backwards, not obliquely upwards and outwards along the canal. Sometimes through a small hole in the transversalis fascia a definite tubular sac appears.

The treatment is more difficult than with the oblique variety. In the ordinary form there is no sac with a neck to tie off; only some redundant peritoneum, which, when removed, leaves a wide gap for suture. When there is a tubular sac this is ligated as in the oblique variety, and the hole in the transversalis fascia closed. If the ordinary operation does not appear sufficient, a flap of the rectus sheath may be turned downwards and sutured to Poupart's ligament to strengthen the weak spot. There is more likely to be a recurrence.

Femoral Hernia

A femoral hernia is one where the sac passes down through the crural canal and appears in the thigh below Poupart's ligament. Femoral hernia is not seen in children and not usually under 20 years of age. It is commoner in women than in men, perhaps because the pelvis is relatively wider. The sac is covered by extraperitoneal tissue (septum crurale), a layer from the femoral sheath, one from the cribriform fascia, by the subcutaneous tissue and the skin. Very often the lump consists largely of a mass of extraperitoneal fat, and there is a very small sac. For this reason an impulse is sometimes difficult to detect, more particularly as omentum is found within the

sac of a femoral hernia more frequently than gut. The bladder may be dragged into the hernial opening on the inner side of the sac. A Cloquet hernia is one in which the sac does not bulge forwards through the saphenous opening but burrows into the pectineus muscle. Very rarely a femoral hernia comes down on the outer side of the femoral vessels (Hesselbach's hernia).


Right femoral hernia; below Poupart's ligament. Left inguinal hernia; above Poupart's ligament. Pubic spines marked by dots.

The diagnosis of a femoral hernia is not always easy. It has already been pointed out that the smallness of the sac may render the detection of an impulse difficult. The large mass of extraperitoneal fat may simulate a lipoma very strongly.

A pouch of the upper end of the internal saphenous vein gives rise to a soft compressible swelling with an impulse, but a fluid thrill accompanies the impulse on coughing. A psoas abscess causes a swelling below Poupart's ligament which has an impulse, but there will be a continuation of the swelling above Poupart's ligament, and fluctuation can be obtained between the two parts. Sometimes an enlarged lymphatic gland causes great confusion. It is situated just over the saphenous opening and the thickened lymphatics running up the crural canal are like the connections a hernia has with the abdomen. The lack of abdominal symptoms combined with the inflammatory nature of the lump, and the discovery of a primary source of infection, usually make matters clear. In a fat person a small femoral hernia may easily be overlooked, even when it is strangulated; for these hernias sometimes contain only a part of the circumference of the bowel (Richter's hernia). Femoral hernias are more apt to become strangulated than inguinal hernias owing to the smallness of the crural ring and the sharp edge of Gimbernat's ligament.

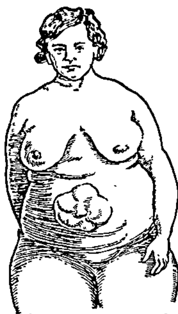
Occasionally there is a little difficulty in distinguishing an inguinal from a femoral hernia. An inguinal hernia lies above Poupart's ligament which can always be palpated, whilst a femoral hernia is below; again the former lies to the inner side of the spine of the pubis, the latter to the outer side.

The treatment of a femoral hernia with a truss is not satisfactory; if the truss presses hard enough to retain the hernia it is liable to cause undue pressure upon the femoral vein, and at the same time be

painful from pressing against the pubic spine. Nevertheless many patients manage with trusses. Particularly owing to the fact that strangulation occurs in a high proportion of cases, an operation should be recommended. The best procedure is to expose the sac below Poupart's ligament, ligate it high up and remove it. The inner end of Poupart's ligament is then sewn down to Cooper's ligament running along the ramus of the pubes. Some surgeons perform the operation from above Poupart's ligament (Lottheisen's operation), claiming that they can ligate the sac higher and bring about a surer radical cure. This is not so if a careful dissection is made below, and there seems no reason for making an incision in the abdominal wall which can be avoided.

Umbilical Hernia

Umbilical hernia is congenital, in which case the child is born with a loop of gut in the umbilical cord, or acquired. The congenital form is very readily recognisable. It is not a hernia in the strict sense of the word, as the loop of intestine has never been within the abdomen. It is clearly seen through a thin transparent membrane.


An umbilical hernia in a characteristically fat woman. Coils of intestine can be seen through the thin coverings of the sac.

Acquired umbilical hernia can develop a few weeks or months after birth, the scar at the umbilicus giving way because of a cough or some other cause for straining (infantile type); or it is seen in adults, particularly in middle-aged fat women who have had a number of children. The hernial opening is above or below the umbilical scar itself.

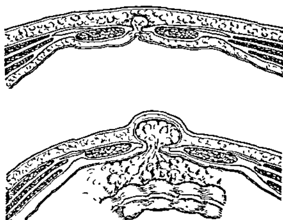
In infants the opening will sometimes close if a pad such as a flat cork is kept in place over it with strapping. But if a hernia is not cured by two or three years it had best be operated upon. If the incision be made just above or below the umbilicus this structure can be left, which is an advantage. Subcutaneous ligation of the neck of the sac is not recommended because there may be a persistent Meckel's diverticulum attached to it. In adults an umbilical hernia may reach a large size. It always contains omentum, and may have the transverse colon in it; less commonly the small intestine is there. Owing to friction on the clothes inflammation very

often occurs, so that quite extensive adhesions of the omentum to the sac are almost the rule. Strangulation too is frequent. For this reason an operation is always to be recommended. It is not without some danger. These obese patients are apt to have fatty hearts; the reposition of a large mass of omentum into the abdominal cavity may interfere with the action of the diaphragm and so lead to chest complications. It is advisable to give them two weeks' rest in bed before doing the operation.

The method of action is a little different from that employed for most hernias. The lump is surrounded by a transversally placed elliptical incision at its base. The sac is opened at its neck where there are no adhesions. It is often advisable to sever the omentum as it comes out of the hernial aperture, thereby removing the overlying skin, the sac and its contents with all the adhesions untouched in one piece. Firm closure of the opening into the abdomen is obtained by overlapping by suture the aponeurosis transversely.

Ventral Hernia

Ventral hernia is the term given to a hernia through the linea semilunaris, through the linea alba or through the scar of an abdominal operation. Above the umbilicus, small lobules of extraperitoneal fat may protrude through the apertures which give passage to blood-vessels. They increase in size and drag after them peritoneal sacs, in which omentum is most likely to be found.



Transverse section of abdominal wall to show the genesis of a hernia in the linea alba. In the upper figure a lobule of subperitoneal fat has been forced through one of the apertures of the linea alba which afford passage to blood-vessels. In the lower figure a peritoneal sac has followed and contains *great omentum*.

As a rule these hernias are small but occasionally they become quite large, when they form a transverse swelling in the epigastrium with all the characteristics of a hernia.

Hernias below the umbilicus are seen more often in thin women with stretched abdominal walls. The recti muscles separate and a bulge appears between them.

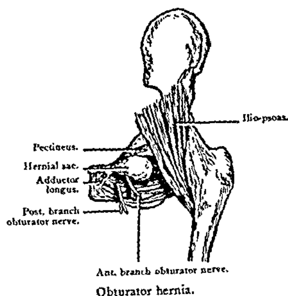
Hernia in the linea semilunaris is rare. Its genesis is the same as that of the hernia in the linea alba.

Post-operative hernia may be seen anywhere an incision has been made. Infection of a laparotomy wound predisposes to hernia formation.

All these hernias are treated by removing the sac and repairing the abdominal wall, using, wherever possible, fibrous tissue for the repair material.

Obturator Hernia

Obturator hernia is very rare. The sac comes out of the abdomen through the obturator foramen. A loop of the lower ileum is usually within it. In most cases the hernia passes beneath the pectineus muscle, but sometimes it follows the posterior division of the obturator nerve and lies embedded in the obturator externus muscle. These hernias are very likely to become strangulated and are very seldom diagnosed. Pain is referred along the course of the obturator nerve to the knee. A tender swelling can be felt deep in the obturator region. Frequently the abdomen is opened for intestinal obstruction, and the nature of the case only revealed on the exploration. Anyhow, this is the best route for treating such a hernia. The contents are reduced from within, the sac inverted into the peritoneal cavity, cut off, and the aperture closed.



Obturator hernia.

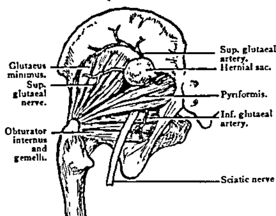
Sciatic Hernia

A sciatic hernia is a protrusion through the sciatic notch. It appears as a rule above the pyriformis muscle, but sometimes below it. It is discovered when it becomes strangulated. Like an obturator hernia, it is best treated by laparotomy.

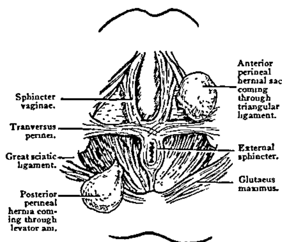
Perineal Hernia

Perineal hernia is also very rare. The sac forces its way between the fibres of the levator ani muscle. In women this may occur at the side of the vagina, the hernia then thrusting itself through the triangular ligament and appearing in the labium majus (pudendal

hernia). In men the hernia only comes down between the rectum and bladder and appears behind the transversus perinei muscles, passing into the ischio-rectal fossa (glutaeal hernia). A similar hernia



Sciatic hernia.



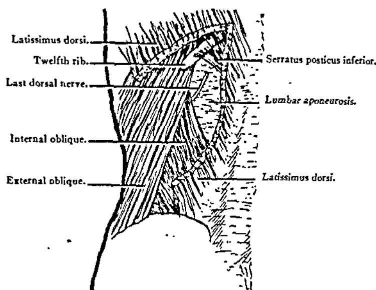
The two forms of perineal hernia.

is met with in women. Here also the hernia can be best dealt with after opening the abdomen.

Lumbar Hernia

Lumbar hernia is usually a hernia through the scar of an operation on the kidney. A spontaneous hernia very seldom occurs. It emerges through one of two spaces: the upper lumbar space bounded above by the serratus posticus inferior and the last rib, to the inner side by the ilio-costalis, to the outer side by the external oblique, and below by the internal oblique; the lower lumbar space or triangle of Petit bounded by the latissimus dorsi, the crest of the ilium and the

external oblique. If such a hernia should be met it should be operated upon, the sac removed and the hernial aperture closed.



Anatomy of lumbar hernia and exposure of the kidney by the oblique lumbar incision.

Diaphragmatic Hernia

This variety is not so rare. It may occur between the sternal and costal origins of the diaphragm (foramen of Morgagni), between costal and lumbar origins behind just above the ligamentum arcuata externum, through the oesophageal opening, or through a defect usually in the central tendon of the diaphragm on the left side. Such hernias may be congenital or acquired.

Traumatic hernias occur as the result of some accident. A traumatic hernia never has a sac; the other forms may or may not have one.

The stomach is the organ most frequently found in the hernia; next in frequency comes the small intestine. An individual may live for long with a diaphragmatic hernia without being aware of its presence. *It may be discovered by accident on* a clinical examination of the chest, the gastric resonance being very evident where the lung percussion note should be heard. The symptoms caused by a diaphragmatic hernia are of two kinds: dyspnoea and attacks of cyanosis, and digestive disturbances. The diagnosis of gastric *ulcer* or *gallstones is often made and only corrected when the* X-ray is taken. The hernia may become strangulated. Then there are sudden, severe pains in the epigastrium, vomiting and dyspnoea. The stomach is usually incarcerated, so the abdomen is hollow. Nothing is passed from the bowel. *There is intense thirst.*

The diaphragmatic hernia should not be operated upon unless it is causing symptoms which are more than mild. The abdominal route is the one usually employed, but access is sometimes difficult by this method; so some surgeons prefer to do a thoracotomy and tackle the hernia from above the diaphragm. A combined abdominal and thoracic route is sometimes used. The most difficult variety in which to effect a cure is that which is at the side of the oesophagus, for space must be left for the passage of this tube and this predisposes to a recurrence. Crushing the phrenic nerve by paralysing the diaphragm may afford help in performing the operation.

CHAPTER XXXI

DISEASES OF THE RECTUM

Congenital Anomalies of the Rectum

Children are born occasionally with a defect in this region. The commonest is a failure of the anal canal to join up with the rectum; there is a thin membrane between the two structures which is easily dealt with by a crucial incision. In another variety the anal canal is represented simply by a depression; the rectum ends blindly above. Sometimes in these cases the rectum opens into the vagina, or the bladder, or the posterior urethra. When opening into the urinary tract, a colostomy must be done; but when there is no fistula of this kind, an attempt should first be made to reach the rectum by dissecting in the perineum; should this prove a failure, then a colostomy must be performed. The fistula between the rectum and the bladder, vagina or urethra will sometimes close spontaneously, so there is no hurry to perform a plastic operation.

Haemorrhoids (Piles)

Internal Haemorrhoids.—Internal haemorrhoids are soft swellings which are formed in the anal canal. The main bulk of a haemorrhoid

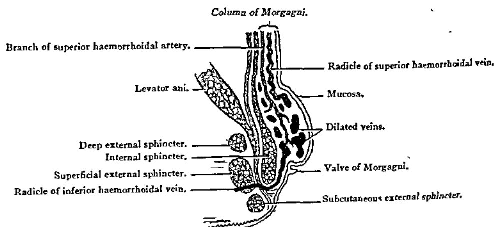
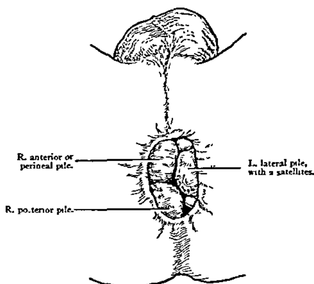


Diagram of an internal haemorrhoid.

is composed of a varicose dilatation of the communications between the superior and inferior haemorrhoidal veins, but there is also a

terminal branch of the superior haemorrhoidal artery which enters it along the column of Morgagni; connective tissue and mucous membrane surround this vascular basis. A haemorrhoid is therefore situated just within the anal canal at the lower extremity of a column of Morgagni. Usually there are not more than three large piles: the first to form is in the right anterior part of the circumference of the anal canal; it is sometimes called the perineal pile; the other two haemorrhoids are situated in the left lateral and the right posterior segments: these latter sometimes have satellite piles on each side of them, the stalks joining together with that of the main pile above.



The usual disposition of internal haemorrhoids, the patient being in the lithotomy position.

The cause of piles is not always clear. Probably there is a congenital predisposition to varicosity, as occurs in the case of varicose veins of the legs; but anything which leads to some hindrance to the return of blood from the anal canal upwards into the portal system may be a predisposing factor; cirrhosis of the liver, the pressure of tumours on the veins in the pelvis, a sigmoid colon loaded with faeces, may all be ranked as such. Sometimes the growth of a carcinoma of the rectum causes a block of the superior haemorrhoidal veins, and, leading to pile formation, reveals itself first in this manner. Pregnancy is a very common cause of haemorrhoids; and so is an enlarged prostate, in this case because of the frequent straining at micturition.

Haemorrhoids are a disease of adult life. They first give notice of their presence by bleeding from the anus on defaecation. In the early stages, the pile does not protrude outside the anus; in the second

stage it comes out during the act of defaecation but subsequently recedes when it is completed; in the third stage, the piles come down and remain, unless they are replaced. In the last class of case the tone of the sphincters is lowered, so that often, when the patient stands, the piles prolapse; such prolapse is accompanied by the secretion of much mucus. Internal haemorrhoids are too soft to be felt with the finger introduced into the anal canal; they can only be diagnosed by actually seeing them, which is done by inspecting the anal canal through a tubular proctoscope. The lower end of a haemorrhoid is often continuous with a tag of skin at the margin of the anus and the dilated veins may extend downwards beneath this skin (external haemorrhoid).

Certain complications occur: a proctitis is common, and from it organisms may pass along the lymphatics to the ischio-rectal fossa and cause an abscess in that situation; the pile itself may become infected and then thrombose, but clotting is more often caused by the pile becoming strangulated when it is prolapsed, owing to a spasmodic contraction of the sphincter muscle: the pile swells up, hardens, becomes blue and then black in colour and gangrenous; ulceration follows, with sepsis, which may actually lead to portal pyaemia. Mild attacks of inflammation in piles are very common; they cause the pile to swell, become painful and the skin at the anus oedematous. The bleeding which occurs with piles sometimes is so profuse that the patient becomes quite anaemic; severe anaemia is seen particularly when ulceration of the pile leads to the erosion of the central artery, for, while the usual venous haemorrhage is dependent on the venous obstruction when the pile is prolapsed, and so stops immediately it is replaced, bleeding from the artery continues into the cavity of the rectum, where it goes on unperceived by the patient.

When the piles are only of the first degree but little treatment is required except the proper regulation of the bowels. In the second degree haemorrhage is an indication, and in the third degree the continued prolapse also.

Haemorrhoids may be cured either by injection or by operation.

The injection treatment aims at causing a fibrosis of the connective tissue of the pile by introducing an irritant fluid into the upper extremity of the pile. This fibrosis obliterates the veins by compression. Through a proctoscope about 3 c.c. of a 5 per cent solution of carbolic acid in almond oil, or 2-5 ♏ of 20 per cent carbolic acid in glycerin, are injected into the submucous tissue at the upper end of the pile. The injection may have to be repeated, and it is best to do only one pile at each sitting. The patient need not be in bed.

Injections should not be carried out in prolapsed piles or gangrene is likely to set in.

The best operation for piles is the so-called ligature operation in which the pile is dissected off the muscular coat of the anal canal upwards until a pedicle is formed, which is ligated; then two-thirds of the pile are cut away. The tag of skin corresponding to the pile must also be cut off. Operations in which the pile is removed and the wound sewn up are not so desirable because, as it is impossible to make the mucous membrane aseptic, the sewing may introduce infection and lead to a submucous abscess. Before such operations the colon should be well cleared of faecal material, and afterwards the bowels should be kept closed for 4 days by giving such drugs as opium, catechu and bismuth. The first action may be made less painful by the introduction of some olive oil into the rectum when it is due to occur.

When strangulated piles are seen soon after the accident has happened, it is sometimes possible to replace them under anaesthesia; but it is useless to attempt this if they have been down for any length of time and caused much surrounding oedema, as they will immediately reappear at the anus after reduction. At this stage the patient should lie in bed and have hot fomentations applied. This will give much relief, the pile will gradually shrink down and perhaps disappear; or if it does not, it can be removed a month or two later. It is dangerous to operate when strangulation is present because of the sepsis.

An external pile is no more than a tag of skin around the anus, sometimes with dilated veins beneath, which are continuous with those of an internal pile with which the redundant skin merges. A thrombosed external pile is a small haematoma which has come from the rupture of a vein at the anal margin. This accident frequently happens during the straining at defaecation. It gives rise to a considerable pain which can be speedily relieved by incising the skin and letting out the blood-clot, a small operation which is easily done under local anaesthesia.

Prolapse

Prolapse of the rectum is either partial or complete. Partial prolapse is protrusion of the mucous membrane only (prolapsus mucosae recti), complete prolapse is the descent of the whole bowel (procidentia recti).

Prolapse of the mucous membrane is seen in children of 1 to 3 years of age. It is caused by straining at defaecation due to con-

stipation, or to a polypus or worms, or to stone in the bladder, or, much less commonly, to diarrhoea. In adults it is associated with piles and is seen especially in old people.

In the treatment of prolapse of the mucous membrane, all causes for it should first be removed. Thus threadworms must be got rid of, a stone in the bladder extracted, constipation or diarrhoea corrected, an enlarged prostate dealt with. In young children nothing more is usually necessary than the regulation of the bowels with some mild aperient such as pulv. glycyrrhizae co., syrup of figs or milk of magnesia. The child should be got into a good habit of emptying the bowel immediately after breakfast; it should not be allowed to sit straining on a receptacle for a long time. The general health must be improved, for prolapse often is seen in weakly infants. When these simple measures do not suffice, the mucous membrane is cauterised along three or four vertical lines either with the actual cautery or by painting the membrane with nitric acid. This causes the mucous membrane to adhere to the muscular coat and cures the condition. An injection of 0·25 c.c. of absolute alcohol in three or four places will be equally effective. In adults, prolapsus mucosae recti is usually cured by removing internal haemorrhoids; if there are no piles, a very similar ligature operation which takes away some of the redundant mucous membrane is done.

Complete prolapse of the rectum is the result of some defect in the floor of the pelvis, a weakening due to wasting during some severe illness, measles, pneumonia, typhoid fever and so on. The condition is diagnosed by the greater thickness of the wall of the protruded part, which takes the form of a cylinder curved backwards with the aperture of the anus at its extremity, and its mucous membrane thrown into concentric folds.

Procidentia of the rectum is difficult to treat successfully in adults, easy in children. The general health must be built up if there has been any wasting disease. This may be sufficient. It is only in adults that operations must be done, and these do not always meet with success. All causes for straining must of course be eliminated first. Rectopexy consists in fixing the rectum to surrounding parts. An incision may be made between the anus and coccyx and gauze packed in the space in front of the sacrum so that the bowel becomes adherent here and prolapse is prevented. The healing-up of this gauze-packed cavity takes 6 or more weeks. Fixation of the sigmoid to the side of the pelvis (sigmoidopexy) is usually followed by recurrence. The external sphincter can be exposed and its opening diminished by suture, whilst at the same time the contiguous margins of the levatores ani are sewn together with the same object in view.

In women this operation is combined with perinorrhaphy. It is sometimes best to amputate the protruding part of the rectum.

Fissure

A fissure is a small vertical ulcer at the anal margin nearly always directly posterior in men, sometimes anterior in women. It is triangular in shape, the small base being below. Just here there is often a tag of skin sometimes called the sentinel pile. The ulcer is probably originally a tear caused by the passage of a large hard lump of faecal material. It leads to very severe pain during defaecation, a pain which lasts for an hour or two and makes the patient dread emptying his bowels. The motion may be stained with a little blood. There is always severe constipation. The sphincter muscles are tightly contracted so that it is difficult to introduce the finger into the anus, and indeed no attempt should ever be made to do this as it is so painful. The lower end only of the fissure can be seen with perhaps the sentinel pile.

Recent fissures are cured by the injection of a long-lasting anaesthetic solution into the substance of the external sphincter from a point about 1 inch behind the anus. A good solution is percaine 0·5 per cent, benzyl alcohol 10 per cent, and phenol 1 per cent in almond oil; 5 to 10 c.c. will be required. Liquid paraffin is given to regulate the bowels during the treatment.

When such treatment fails, as it often does, operation is necessary. A knife is directed against the floor of the ulcer and the fibres of the external sphincter divided to a shallow depth. The sentinel pile with a small triangular piece of skin is taken away to provide for free drainage. The wound is plugged with gauze. The bowels should be kept constipated for four days. Cure is certain.

Abscesses and Fistulae in Connection with the Rectum

In this connection, some points in the anatomy of the anal canal are so important that reference must be made to them. The anal canal is 1½ inches long. The upper two-thirds of the passage are lined by mucous membrane similar to that of the rectum with the vertically running columns of Morgagni containing the terminal branches of the superior haemorrhoidal artery. They end below in the valves of Morgagni, the pockets of which are called the sinuses or crypts of Morgagni. Opening into the crypts are sometimes the vestigial remains of branching tubes lined with transitional epithelium; they can be traced outwards through the internal sphincter and

sometimes into the substance of the levator ani muscle; they are called anal glands. The valves of Morgagni form what is called the pectinate line. A little below the line a groove can be felt running round the canal, which marks the place where the lower border of the internal sphincter is separated from the subcutaneous division of the external sphincter by the fibres of the longitudinal coat of the rectum passing between them. This so-called anal intermuscular septum marks the place where the skin joins the transitional epithelium which covers the anal canal below the pectinate line.

The thickened internal circular muscle coat of the rectum forms the internal sphincter and extends downwards as far as the intermuscular septum.

The external sphincter has three divisions; the subcutaneous part forms a ring round the canal beneath the skin. It is separated above from the superficial part of the muscle and the internal sphincter by the intermuscular septum; the superficial external sphincter is attached to the coccyx behind and the central point of the perineum in front; the deep external sphincter is higher up still and lies in close contact with the pubo-rectalis portion of the levator ani; the last two divisions of the external sphincter surround the internal sphincter.

The importance of this anatomy is that sinuses in the region of the anus often communicate with the cavity of the rectum passing between or through one of the muscles. In order to gain free drainage, muscle must be divided, but, unless precautions are taken not to cut across any muscle but the subcutaneous external sphincter, except it be fixed by previous inflammation, incontinence will result.

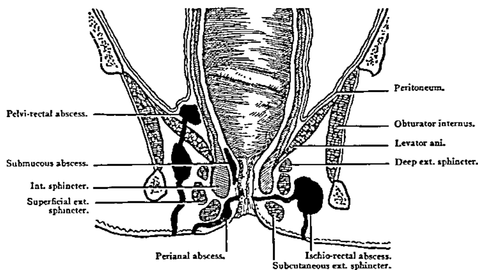
Ano-Rectal Abscess

Abscesses in connection with the anus or rectum arise in several situations.

(1) An *anal* or *perianal* abscess is subcutaneous in position, close to the anus, and comes from the infection of a sweat or sebaceous gland or hair follicle; or sometimes it is due to suppuration in a thrombosed external pile, or to infection spreading from the lower end of a fissure. It causes a certain amount of pain and discomfort but the constitutional disturbance is not great. It may burst on the surface or enter the rectum superficially or deep to the subcutaneous sphincter, thus giving rise to a fistula.

(2) An *ischio-rectal* abscess is one in the ischio-rectal fossa. It is due to infection taking place from the rectum: proctitis associated with piles; bacterial infection of a crypt or one of the anal glands, the organisms getting held up in the lymphatics as they pass across the

space to the iliac glands; infection from an ulcer in the rectum, either inflammatory or malignant. This is a much more serious infection, for, being deeply seated, great constitutional disturbance is caused. There is great pain so that the patient cannot sit or lie in comfort; he prefers to stand. There is a high temperature with perhaps a rigor at the beginning. A hard, very tender mass can be felt in the ischio-rectal fossa but it does not bulge into the lumen of the rectum. These abscesses have a great tendency to break through to the anal canal; the perforation occurs in the groove between the internal and



Suppuration in the region of the rectum.

the subcutaneous part of the external sphincters, usually in the middle line behind. The abscess sometimes invades the opposite ischio-rectal fossa.

(3) A *submucous* abscess is one which forms under the mucous membrane of the anal canal; it comes from sepsis in the canal like the others, and may be due to the catching-up of a foreign body, such as a fish bone, just above the anal margin. The symptoms are comparatively mild. There are pain in the rectum and the sensation of a foreign body being there, but very little constitutional disturbance.

(4) A *pelvi-rectal* abscess is really an abdominal abscess coming from infection in the broad ligament, or prostate, or seminal vesicles, or a diverticulum of the colon, or the appendix, which has burrowed through the levator ani into the ischio-rectal fossa. The symptoms of ischio-rectal abscess are added to those of the primary condition.

Treatment.—A perianal abscess should be opened by an incision which radiates from the anus with, distally, a cross incision making it into a T; the corners of skin are removed to make drainage more free.

For the ischio-rectal abscess, a similar or a crucial incision is used

to let out the pus. The resulting cavity must be packed with vaseline gauze and allowed to heal from the bottom.

The submucous abscess is very easily dealt with. Often it ruptures on digital examination. A simple vertical cut will suffice.

The pelvi-rectal abscess can only be drained by enlarging the aperture in the levator ani after the ischio-rectal abscess has been opened.

Fistula in Ano

Fistula in Ano is the name given either to sinuses or fistulae in the neighbourhood of the anus. They are called blind internal fistulae when they open only inside the anal canal, blind external fistulae when they discharge on the surface, and complete fistulae when they form a communication between the bowel and the outside.

As we have seen, fistulae result from one of the several abscesses which occur in this region. Such fistulae are very persistent, it is said, because they are constantly being reinfected from the bowel, because the walls of the channels are repeatedly being separated by the passage of faeces or flatus along them, and because the constant contractions of the sphincter muscles do not allow the granulations to adhere. There is only one internal opening, but there may be several openings on the skin because the sinus may branch extensively. The internal opening is usually found in the middle line posteriorly between the internal and subcutaneous part of the external sphincter. Sometimes the internal opening is in front, particularly in women. A horse-shoe fistula comes from an ischio-rectal abscess which has invaded the opposite ischio-rectal fossa. In a minority of fistulae the track passes deep to the superficial or deep parts of the external sphincter and through the substance of the internal sphincter; these are called high-level fistulae. The external openings of fistulae have, as a rule, red granulations protruding from them which designate them as septic in origin. Undermined bluish openings arouse the suspicion of tuberculosis. The internal opening feels like a buttonhole to the exploring finger. It can sometimes be seen through the proctoscope and a probe passed into it.

In order to get these fistulae to heal, the freest possible drainage must be obtained. A grooved director is passed into the external opening and a knife run along it to convert the canal into a furrow. All branches are searched for and dealt with in the same way. The treatment of the deep part going into the rectum is left until the last and sometimes must be postponed to a future occasion. When the finger feels that the internal opening is assuredly in the sulcus between

the internal and the subcutaneous part of the external sphincter, the director may be passed through it into the lumen of the rectum and the subcutaneous external sphincter cut across, care being taken that the muscle fibres are divided at right angles to their direction. Any corners of skin which may impede drainage are cut off and the extensive wound packed with vaseline gauze and allowed to heal from the bottom, a process which may take a number of weeks. Should the internal opening pass through the internal sphincter, that is, should it be above the anal intermuscular septum, then the muscle superficial to it must not be divided under any circumstances, for incontinence will invariably follow. A thick silk ligature is passed through the high opening and very loosely tied. Its presence causes fibrosis in the neighbourhood of the muscle and fixes it, so that, when the external wound is healed, the muscle can be safely cut across without its severed ends retracting and leading to incontinence. This is the operation in two stages; it must always be used for the high-level fistulae. Blind external fistulae must usually be converted into complete fistulae and treated as such before they will heal.

Ano-Rectal Tuberculosis

About 15 per cent of cases of fistula are tuberculous in nature, either the bacilli can be found in the discharge or granulations from the wall show tubercles on section. There are two types of tuberculous fistula, the superficial and the deep. The superficial variety is seen as a small opening in the neighbourhood of the anus leading into a track which remains near the surface. The mouth of the fistula is undermined and bluish in colour like all tuberculous sinuses. The discharge is watery in appearance. There is not usually an opening into the bowel.

The deep fistula has an opening at the side of the anus and runs upwards for some distance along the bowel, with which it may or may not have a communication. The superficial variety can be cured by surgery. It is laid freely open, if necessary into the anal canal, when it tracks under the skin overlying the subcutaneous external sphincter. Corners of skin are removed and the resulting flat surface cauterised with the diathermy cautery. The disease can often be eradicated in this way.

The deep form should not be submitted to any operation as it is incurable by this means. At most a little freer drainage may be afforded by an incision. Many of the subjects of tuberculous fistula suffer from phthisis.

Fibrous Stricture of the Rectum

Fibrous stricture of the rectum is rare. It results most frequently from an operation on the anal canal, such as an operation for haemorrhoids in which too much mucous membrane has been taken away. After the amputation of a prolapsed portion of the bowel, or a resection of a growth with end-to-end anastomosis, a linear stricture is not uncommonly seen. The radium treatment of carcinoma of the cervix uteri is sometimes followed by a most intractable kind of stricture. In those countries where lympho-granuloma inguinale is found, this disease leads to the formation of a massive fibrosis all round a considerable length of the rectum and great narrowing. The infection coming from the primary lesion in the vulva is carried by the lymphatics to the glands within the pelvis and from them spreads to the cellular tissue in the neighbourhood. The Frei intradermal test confirms the diagnosis. Such strictures are sometimes met with in this country.

When a linear stricture develops after an operation on the rectum, careful dilatation should be carried out by the finger. The use of dilators is dangerous if the stricture is not within easy reach of the finger. These annular strictures quite commonly dilate spontaneously if the motions are allowed to remain solid; if, by the taking of aperients, they are kept liquid, the stricture will get narrower and narrower. Only very exceptionally is it necessary to cut the fibrous ring in two or more places from within the bowel (internal proctotomy).

The tubular and extensive strictures which occur in lympho-granuloma inguinale, and after the use of radium, cannot be cured by dilatation; for them, a colostomy may be necessary to bring relief. (See page 53 for the treatment of lympho-granuloma.) Such strictures can occasionally be excised and an end-to-end anastomosis performed.

Pruritis Ani

Pruritis ani is a condition in which there is troublesome irritation around the anus. More often than not it is caused by some infection coming from the anus. Thus it is seen when there is much mucous discharge associated with internal piles, with fistula, fissure, or even with a simple proctitis. Threadworms or infection with the epidermophyton also cause it. But, putting aside all these cases, there are patients who suffer almost intolerable itching for which no cause can be found.

In pruritis the skin around the anus is white and thickened and shows radiating cracks and usually evidence of scratching

A search for the cause must be made, and if possible it must be removed. Threadworms can easily be got rid of; but, if scrapings of the skin show the presence of the epidermophyton, treatment is not so easy. Such an infection has spread from the lesion between the little and fourth toes which it is frequently impossible to cure. Fortunately it can be kept under control by salicylic applications and a drying dusting powder in the cleft between the toes, and the eruption round the anus can be cured by tinct. of iodine, or 1 per cent gentian violet in spirit. Haemorrhoids, fistula or fissure must receive the appropriate treatment. For the idiopathic forms where there is no assignable cause an anodyne ointment (zinc cream containing 2 per cent benzocaine or phenol) may be prescribed; or the subcutaneous injection all round the anus of a percaine in oil solution, referred to on page 423, will bring relief. Ball's operation of undercutting the perianal skin so as to sever all the sensory nerves should only be done when all other methods have failed, as, apart from the fact that it is not always successful, sepsis and subsequent trophic changes in the skin may lead to trouble in the future.

Tumours of the Rectum and Anus

Rectum:
Simple: (1) Adenoma.
(2) Papilloma.
(3) Fibroma.
Malignant: Carcinoma.
Anus:
Simple: Papilloma.
Malignant: Carcinoma.

Adenoma of Rectum

Adenomata of the rectum form spherical growths of small size, attached by a pedicle to the wall of the bowel. On the surface they are bossed and of a reddish colour, looking something like a mulberry. They are seen more often in children than in adults. They are usually called polypi. A variety of adenoma met with in adults is sessile, forming a rounded tumour projecting from the mucous membrane. Quite commonly there are more than one present.

No symptoms are caused by adenomata unless ulceration and bleeding with perhaps infection occur. Infection leads to rectal irritation and the discharge of mucus. Owing to the attempts of the

bowel to get rid of what is to all intents and purposes a foreign body in its lumen, there results either some intussusception of the bowel (if the growth is highly situated), or a great elongation of the pedicle so that the tumour can prolapse from the anus. Stalked adenomâta are innocent, but the sessile, multiple variety, although they remain harmless for years, have a tendency to become carcinomatous and should be regarded as an ever-present danger. More than one of the tumours may undergo malignant degeneration almost at the same time.

The diagnosis of a polypus in a child is made by digital examination of the rectum; the soft, rounded, movable tumour can be felt fixed by its stalk to the rectal wall. Sessile adenomata can be diagnosed only by seeing them through the proctoscope or the sigmoidoscope.

Stalked polypi in children are simply removed by delivering them from the anus, ligating the pedicle and cutting them away.

Sessile adenomata are removed when they are near the anus by cutting them off with a little normal mucous membrane and ligating or suturing the base, the sphincters having been stretched. When they are higher up they can be destroyed by the diathermy cautery through the sigmoidoscope. The disadvantage of this method is that no microscopical examination can be made to determine if malignant change has taken place; the patient must therefore be sigmoidoscoped at intervals in order to watch for any recurrence.

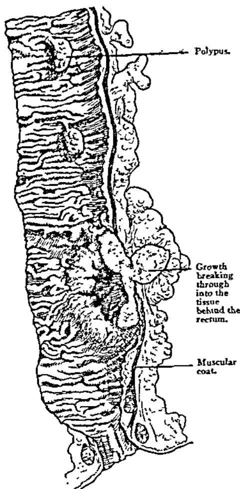
The papilloma is met with as a flat villous growth. It is seen only in adults and, although it may be innocent for many years, it has a disposition to take on malignant growth. It causes bleeding, irritation of the rectum and, characteristically, a rather profuse discharge of mucus. However, unless bleeding, ulceration or infection take place, a villous tumour may exist for very long quite unsuspected. After dilating the sphincters the low-situated villous tumours can be removed through the anus. Those higher up in the bowel must be approached either from the back by removing the coccyx, or, if they are higher still, from the abdomen. A resection of the whole circumference of the bowel with an end-to-end anastomosis is necessary when the growth has extended far round the rectum.

The fibroma, or fibrous polypus, seen in the rectum is usually the result of inflammation and thrombosis in a haemorrhoid. It is very simply removed.

Carcinoma of the Rectum

Excluding the stomach, the rectum is the commonest situation for carcinoma in the alimentary canal. It is commoner in men.

It is a columnar-celled growth, often scirrhous in character. It may take the form of a malignant ulcer or be a cauliflower tumour. It tends to grow round the bowel and cause obstruction. Its manner of spread is important. Locally it grows along the wall of the intestine, but much more in the upward than the downward direction; malignant cells are not likely to be seen beyond $1\frac{1}{2}$ cm. below the margin of the growth in any case which is operable. A nodule of tumour is sometimes seen coming through the muscular wall posteriorly into the connective tissue here, and it also is rather liable to break through the recto-vesical pouch in front. The pelvic fascia behind offers a considerable resistance to penetration, so that true fixation to the sacrum is not frequent. On the other hand, it more easily gets into the prostate, or vaginal wall. The lymph from the rectum (apart from the anal canal) flows upwards behind the viscus into glands which lie in the meso-rectum and mesosigmoid. There is no flow outwards across the ischio-rectal space, nor downwards towards the anus. Spread also takes place by the blood-stream, and so the growth reaches the liver. In later stages, when all possibility of removal is gone, the growth may be found invading the cellular tissue of the pelvis, almost filling it, breaking into the bladder or vagina with the formation of fistulae, involving the nerves of the sacral plexus, and disseminated in the peritoneum.



Carcinoma of rectum.

Unfortunately, like carcinoma in other places, the growth is often silent for a long time, so that many patients arrive too late for a radical operation to be possible. In other cases, owing to the injury by hard faeces to which growths in the rectum are subjected, bleeding occurs early. Haemorrhage, in fact, is usually the first sign of carcinoma of the rectum. Rarely, the bowel becomes so constricted that acute intestinal obstruction occurs as the first thing of which the patient

really takes notice. A gradual narrowing of the lumen causes constipation, and attacks of mild colic after meals, with a feeling of fulness in the abdomen, which the patient refers to as indigestion. There are also attacks of spurious diarrhoea. These are caused by the faeces being held up above the narrow part of the bowel and becoming liquefied by bacterial activity. This spurious diarrhoea happens particularly in the morning on getting out of bed. There is much mucus in the motions because of the proctitis always present. There may be irritation of the bladder if the growth is encroaching on it; and in late stages, very great pain should the sacral plexus be invaded. This pain is felt along the distribution of the sciatic nerve.

If there is obstruction of any degree, the abdomen is full, and perhaps the caecum can be felt distended. A secondary growth in the liver is sometimes palpable. The tumour can be felt on rectal examination with the finger. It has a hard edge, is friable, and the finger, when removed, has blood and mucus on it.

When a small adenoma is the cause of the bleeding, some doubt about its nature may exist, an uncertainty which can usually be resolved by proctoscopy. An adenomatous polypus becoming malignant can be recognised by its colour; innocent papillomata are pale, but those undergoing malignant change are reddish blue. The rectum above a small adenoma should always be examined, because such tumours are often multiple and more than one may become malignant. Fortunately, from a surgical standpoint, the lowest one is the first to undergo this change.

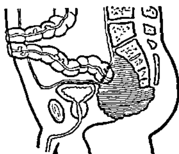
Invasion of the bladder causes hyperaemia which can be seen with the cystoscope. A growth apparently fixed to the sacrum can often be separated from this bone because it has not penetrated the pelvic fascia. The barium enema is not necessary for low growths, and for those higher up it is not always decisive, owing to the fact that a coil of colon may obscure the situation of the growth in the rectum.

A carcinoma of the rectum is excisable when it is confined to the bowel, and is not invading neighbouring structures; that is, it has not grown into the bladder and is not inseparably fixed to the sacrum. In women a part of the vagina, and in men a slice of the prostate, can be taken away with the growth if these structures are not too extensively invaded.

The following methods of excision of the rectum are practised: (1) perineal excision, (2) abdomino-perineal excision, (3) resection with restoration of the continuity of the bowel.

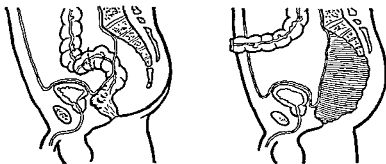
Perineal Excision.—*A preliminary laparotomy is performed whereby the presence of a secondary growth in the liver can be*

discovered, or an extension into the peritoneum or to the glands, which render the case unsuitable for removal. At this operation an inguinal colostomy is done. About 2 weeks later the rectum is excised from the perineum; the anal canal, the growth with a mass of tissue on either side, and a large part of the bowel above, are taken away, and the blind end of the colon closed by sutures. The resulting cavity takes some weeks to heal.



Perineal resection of the rectum. A permanent colostomy has been made previously. The distal end of the colon is closed and the peritoneum stitched round it.

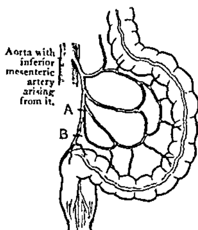
Abdomino-Perineal Excision. — The rectum is freed from above right down to the floor of the pelvis. The sigmoid colon, near its upper part, is cut across and its proximal end brought out on the surface of the abdominal wall to form a colostomy. The bowel below this is then pushed down into the depth of the pelvis and the peritoneum over it reconstituted to form a new pelvic floor. The abdomen is then closed. An incision is now made from the lower end of the sacrum to the anus and encircling it. Through this opening the whole of the lower part of the sigmoid, the rectum and anal canal, and the tissues of the ischio-rectal fossae, are excised.



Abdomino-perineal resection of rectum, showing the part removed and the large cavity left.

Conservative Resection.—This operation should probably be done much more often than it is. Pathological research shows that it is quite unnecessary to take away as much tissue as is ordinarily done in the perineal or abdomino-perineal operations. No more of the bowel than 2 cm. need be removed below the growth, and, as there is no lateral spread, the tissue in the ischio-rectal spaces can be preserved. In the upward direction, however, a large piece of the intestine with the mesorectum, and the mesosigmoid require removal. The upper end of the colon is then sutured to the lower extremity, so that the patient retains his anus and no colostomy is necessary.

Such an operation is an *immense advantage* over those which leave him with an artificial anus. It should always be done when the growth does not encroach too far downwards *into the region* of the sphincters. Abroad, the procedure is usually carried out from the sacral region after removing the coccyx and the lower two pieces of the sacrum; but it is preferable to begin the operation by a laparotomy, so that the extent of *the growth and the presence of* secondaries can be accurately determined. The bowel can then be dissected free from above, and the blood-supply more certainly preserved. The rest of the operation is then finished through a sacral incision without removing more than the coccyx. A tube is passed up the rectum beyond the suture line. The anastomosis always leaks but the fistula closes by itself.



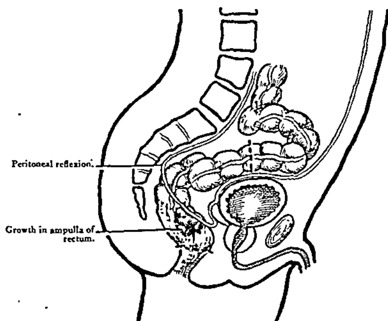
The blood-supply of the rectum. In removal of the rectum the superior haemorrhoidal artery must be tied at A above the origin of the lowest sigmoid branch; if tied at B gangrene of the stump of the bowel may occur.

A number of carcinomata of the rectum can be removed and *continuity of the* bowel restored operating from the abdomen alone. After ligature of the superior haemorrhoidal artery, the bowel is freed down to the pelvic floor. Division of its lateral ligaments will allow *the rectum to be pulled* upwards, so *that it can be* cut across below the growth. A long length of bowel with mesorectum and glands is removed and the sigmoid sewn to the rectal stump. Some soiling is unavoidable. Its danger is lessened *if*, for four days before his operation, the patient be given sulphathalidine 1.5 gm. every 4 hours (omitting one dose during the night). Sulphathiazole and penicillin powder is scattered in the hollow of the sacrum, and a tube, which emerges from a stab wound in the left iliac fossa, is inserted for drainage. *A tube should also be passed up the anus beyond the* suture line. From this operation the patient recovers much more quickly than from the abdomino-sacral or abdomino-perineal operations.

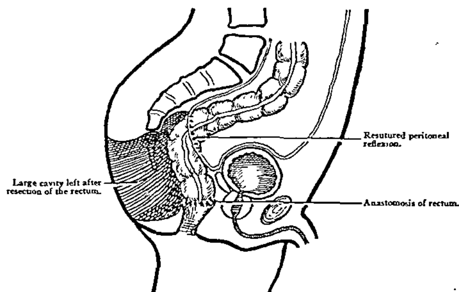
Carcinoma of the Anal Canal.—When the growth reaches down to the anal canal, it is not possible to carry out the conservative operation, and if it is low down in the canal, the lymphatic *drainage* will also take place laterally into the inguinal glands. In these cases the anal canal and sphincters and tissues in the ischio-rectal fossae must be *taken away and the patient must have a permanent* colostomy. With low growths the inguinal glands should be removed.

When it is found that it is quite impossible to remove *the growth* in the rectum or anal canal, a colostomy should be performed in the

left iliac fossa. Life is thus preserved for a considerable time in some comfort. *With such an artificial anus the patient must wash out the* bowel every morning. If he gets the colon empty, and avoids such



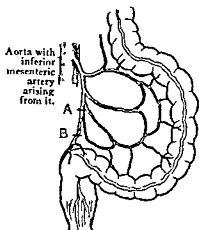
Conservative resection of the rectum. The part of the bowel between the dotted lines is removed.



Conservative resection of the rectum. Restoration of the continuity of the bowel.

foods as experience has shown him cause irritation, there is usually no leak during the next 24 hours. There is no need to wear more than a pad over the colostomy opening. A dilute concoction of

Such an operation is an immense advantage over those which leave him with an artificial anus. *It should always be done when the* growth does not encroach too far downwards into the region of the sphincters. Abroad, the procedure is usually carried out from the sacral region after removing the coccyx and the lower two pieces of the sacrum; but it is preferable to begin the operation by a laparotomy, so that the extent of the growth and the presence of secondaries can be accurately determined. The bowel can then be dissected free from above, and the blood-supply more certainly preserved. The rest of the operation is then finished through a sacral incision without removing more than the coccyx. A tube is passed up the rectum beyond the suture line. The anastomosis always leaks but the fistula closes by itself.



The blood-supply of the rectum. In removal of the rectum the superior haemorrhoidal artery must be tied at A above the origin of the lowest sigmoid branch; if tied at B gangrene of the stump of the bowel may occur.

A number of carcinomata of the rectum can be removed and continuity of the bowel restored operating from the abdomen alone. After ligature of the superior haemorrhoidal artery, the bowel is freed down to the pelvic floor. Division of its lateral ligaments will allow the rectum to be pulled upwards, so that it can be cut across below the growth. A long length of bowel with mesorectum and glands is removed and the sigmoid sewn to the rectal stump. Some soiling is unavoidable. Its danger is lessened if, for four days before his operation, the patient be given sulphathalidine 1·5 gm. every 4 hours (omitting one dose during the night). Sulphathiazole and penicillin powder is scattered in the hollow of the sacrum, and a tube, which emerges from a stab wound in the left iliac fossa, is inserted for drainage. A tube should also be passed up the anus beyond the suture line. From this operation the patient recovers much more quickly than from the abdomino-sacral or abdomino-perineal operations.

Carcinoma of the Anal Canal.—When the growth reaches down to the anal canal, it is not possible to carry out the conservative operation, and if it is low down in the canal, the lymphatic drainage will also take place laterally into the inguinal glands. In these cases the anal canal and sphincters and tissues in the ischio-rectal fossae must be taken away and the patient must have a permanent colostomy. With low growths the inguinal glands should be removed.

When it is found that it is quite impossible to remove the growth in the rectum or anal canal, a colostomy should be performed in the

CHAPTER XXXII

DISEASES OF THE LIVER

Cholecystitis and Cholelithiasis

Cholecystitis, or inflammation of the gall-bladder, is due, as a rule, to infection with micro-organisms, but it may occur from toxins without the presence of bacteria. In cases of cholecystitis the wall of the gall-bladder is sterile in nearly 50 per cent of cases. The bile itself is sterile in about 60 per cent, so that it would appear that it is possible for inflammation of this viscus to occur apart from infection. The microbes most frequently found are the *Bacillus coli*, streptococci, staphylococci, diphtheroid bacilli and the *Bacillus Welchii*. The gall-bladder is probably infected secondarily to hepatitis. There are very free lymphatic communications between the liver and the gall-bladder and, moreover, when there is acute cholecystitis the right lobe of the liver is very nearly always enlarged and tender. Organisms are taken out of the blood-stream by the liver and destroyed. This function is carried out by the Kupffer cells in the liver. Under normal conditions organisms can be obtained from the liver tissue, the *Bacillus Welchii* almost constantly; and most of the other intestinal bacteria can be obtained from the liver in considerable numbers. Should the Kupffer cells not destroy the bacteria which are removed from the blood-stream, infection of the intrahepatic cellular tissue takes place. This hepatitis spreads to the gall-bladder, causing the cholecystitis. The toxins which produce cholecystitis without microbes are not certainly known. Probably they are the toxins from the destroyed bodies of bacteria which diffuse from the liver substance into the gall-bladder. That toxic cholecystitis is possible is shown by the fact that a number of chemical substances on experimental injection do cause inflammation of the gall-bladder. It has been suggested also that spasm of the sphincter of Oddi may allow pancreatic juice to pass backwards up the cystic duct into the gall-bladder. Here again, experimentally, the introduction of pancreatic juice into the viscus will set up a cholecystitis. On the other hand,

linseed is better than water to irrigate the bowel. The lower end of the intestine containing the growth will also need washing through.

In those cases where the carcinoma is invading the sacral plexus the intolerable pain is combated with morphine. The end of a patient in whom a carcinoma cannot be removed is distressing in the extreme. Every attempt, therefore, should be made, even in unfavourable circumstances, to take away the growth. The mortality of the operation in the hands of a surgeon who does this will rise, but he will, on balance, have done more to relieve suffering than a more cautious colleague.

Sarcoma of the rectum is so rare that it is scarcely of clinical importance. It forms a rapidly-growing tumour which quickly spreads to the surrounding parts.

ance of metabolism which influences the formation of bile acids might quite likely lead to cholesterol being deposited in the gall-bladder, particularly when the concentrating function of the gall-bladder is disturbed. Or a toxic inflammation of the gall-bladder wall may lead to desquamation of epithelial cells which form a nucleus around which cholesterol crystals agglutinate. Pure cholesterol stones are usually single and are found in uninfected gall-bladders, whose walls very often have a healthy appearance. Pure pigment stones occur in such conditions as acholuric jaundice in which there is excessive destruction of red blood corpuscles. They are apt to form in the bile-ducts, whereas ordinary gall-stones are found primarily in the gall-bladder. Calcium carbonate stones are rare. They are found in cases in which the cystic duct has become obliterated. They are not associated with infection. The commonest stones are mixed or combined stones, and are very probably the result of infection of the gall-bladder wall. They are, as a rule, multiple and may be very numerous, several thousands being sometimes found within the gall-bladder. They are angular faceted structures, and in colour they are yellow or greyish-black. Mixed stones are composed very often of a central portion made up of cholesterol crystals and a shell made up of calcium bilirubinate. Cholesterol is transparent to X-rays but the mineral envelope shows up as a ring in the skiagram.

Whilst gall-stones may themselves be the result of infection, which, however, may die out, they may be the cause of a cholecystitis by causing stasis of the bile in the gall-bladder. A stone may become impacted in the cystic duct and lead to obstruction in this way, or it may become tightly wedged in Hartmann's pouch, the bulge at the neck of the gall-bladder which overlaps the cystic duct. When this is tightly distended the cystic duct is compressed and obstructed. Whether the obstruction to the outflow of bile is due to the presence of a stone or to inflammatory swelling in this situation, the infecting organisms come from a hepatitis. The intensity of the inflammation set up varies. There may be nothing more than a catarrhal inflammation which may clear up, leaving as a result a little fibrosis in the gall-bladder wall. Repeated attacks of such catarrhal inflammation result in fibrous thickening of the gall-bladder, a shrinkage and inextensibility. The acute stage of inflammation may proceed to suppuration, with ulceration of the mucous membrane of the gall-bladder and perhaps the accumulation of so much pus that we may well speak

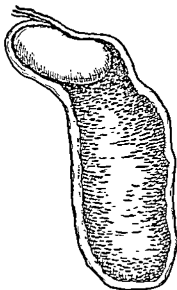


A stone fixed in Hartmann's pouch may cause compression of the common duct and lead to jaundice.

it has also been suggested that a lax sphinctĕr at the lower end of the bile-duct may allow duodenal juice to regurgitate with the same result. In animals, if the cystic duct be tied with bile in the gall-bladder an acute cholecystitis is set up, whereas if the bile be emptied and saline substituted only distension of the gall-bladder takes place. Thus the great part that obstruction to the outflow of bile from the gall-bladder takes in causing cholecystitis is demonstrated. Bacteria seem to invade the gall-bladder walls already damaged by some chemical constituent of the bile. It is also held that certain streptococci may have an elective affinity for the gall-bladder wall, and when injected into the blood-stream, settle down in this situation and cause inflammatory reaction. Whilst there is experimental evidence for this process it is not by any means proved that the massive infection necessary ever actually happens in human pathology.


Mixed gall-stones: a large one in section.

Gall-stones are very frequently found in association with an attack of cholecystitis. Gall-stones may perhaps be the result of an infection of the gall-bladder but, on the other hand, it seems quite clear that certain stones, particularly pure cholesterol stones, may form in a gall-bladder which is sterile and has remained so.


Pure cholesterol gall-stone impacted in Hartmann's pouch and causing obstruction of the cystic duct.

Gall-stones are classified as (1) pure stones, (2) mixed stones and (3) combined stones. Pure stones are made up of cholesterol, bile pigments in the form of calcium bilirubinate, or calcium carbonate. Mixed stones are those which are made up of two or three of the above constituents. Combined stones are stones which have a nucleus of one constituent of the first group, surrounded by a shell of mixed constituents.

The formation of gall-stones is really quite obscure. Cholesterol forms a large proportion of most gall-stones, but it is pretty clear that hypercholesterolaemia does not lead to gall-stone formation. The cholesterol in the bile is kept in solution by the presence of bile salts which, having acted in this capacity, are absorbed from the intestine and utilised again by the liver. A slight disturb

duct, or a stone impacted in Hartmann's pouch pressing against the duct. In this case bilirubin will be detected in the urine.

In the *treatment* of cholecystitis the patient must be relieved of his pain by warm applications to the abdomen, and the administration of morphia or omnopon in sufficient doses. He should be kept on a fluid diet. There is not unanimity as to the advisability of operating, or not, in acute cholecystitis. It is true that the attack nearly always subsides and that diffuse peritonitis is rare. This being so, there is much to be said for nursing the patient through an acute attack and postponing the question of operating until its subsidence. It is felt that early operation may lead to extension of the inflammation if it takes place before local and general immunity have been established. There are also great technical difficulties to be overcome in operating during the acute stage, and the danger of injuring the common bile-duct should cholecystectomy be attempted, owing to the fact that the matting produced by the inflammation obscures the anatomical structures and renders their unravelling difficult and uncertain. On the other hand there is the slight possibility of the inflammatory condition spreading to a diffuse peritonitis and an operation being enforced under the most unfavourable conditions. Recently, earlier operation has been advocated, with what seem to be unusually good results. If the former course is followed, an investigation of the function of the gall-bladder by cholecystography can be carried out as soon as conditions allow and a favourable time can be selected for the operation. Cholecystectomy, that is, removal of the gall-bladder, has proved to be the best operation. Cholecystostomy is opening the gall-bladder, removing the stones and draining it. This operation should only be used if the patient is too ill to withstand the longer operation of removal of the gall-bladder, or if the conditions are so difficult that cholecystectomy cannot be performed without grave risk to the patient's life.

Chronic Cholecystitis

Repeated attacks of catarrhal cholecystitis lead to fibrosis of the gall-bladder wall, which goes under the name of chronic cholecystitis. This condition may occur apart from the presence of gall-stones but it is much more common with them. The chronic inflammation so alters the function of the epithelium lining the gall-bladder and the musculature of its wall that digestion is notably disturbed. The patient complains of discomfort after food, a feeling of fulness, flatulence, and a sensation of weight in the right hypochondrium. He frequently has a distaste for some particular food, very likely for fats. He perhaps suffers from headaches, migraine, chronic constipation

of an empyema of the gall-bladder. In more acute forms even gangrene of the gall-bladder wall occurs, in one or more patches, or more extensively, so that almost the whole of the gall-bladder sloughs. Inflammation of the gall-bladder spreads to the peritoneal surface and sets up a local peritonitis, causing the omentum and neighbouring viscera, particularly the duodenum and colon, to become adherent. Usually this inflammation subsides, but a local area of gangrene may lead to the formation of an abscess outside the gall-bladder. If such abscesses rupture into another viscus an internal fistula results. A communication with the duodenum in this fashion is the commonest of internal fistulae. They also occur in connection with the colon and have been recorded as leading into the pelvis of the right kidney, and the portal vein. Gangrene of the gall-bladder is not very common, far less common than gangrene of the appendix. This is attributed to the fact that the gall-bladder wall is supplied not only by the cystic artery but by other arteries emerging from the surface of the liver. A quite rare complication is gangrene of the gall-bladder, leading to diffuse peritonitis. In nearly every case localisation occurs. Quite rarely, too, an abscess around the gall-bladder may perforate in the region of the umbilicus, forming an external fistula from which gall-stones may escape. Or, reaching the subphrenic space, an abscess may penetrate the diaphragm and cause an empyema. Such an empyema may actually point between the ribs, discharge on the surface and expel gall-stones by this route.

The symptoms of acute cholecystitis begin with a severe attack of pain in the upper region of the abdomen. There is frequent vomiting and there is tenderness in the right hypochondrium. The temperature rises to 101-102°. The pain is apt to be referred to the region of the right shoulder-blade. On palpation of the abdomen it is usually possible, because rigidity is not "board-like", to feel a swelling in the region of the gall-bladder. The liver dulness is increased and the liver area is tender. Acute cholecystitis is nearly always associated with obstruction of the cystic duct, whether by stone or by inflammatory swelling in this region. Particularly with stone there are exacerbations of biliary colic in which the pain, in spasms, becomes much more intense owing to the gall-bladder contracting forcibly in an attempt to expel its contents. If the inflammatory condition spreads through to the peritoneum, rigidity becomes more pronounced and the area of tenderness is increased. The formation of an abscess is indicated by a continuing high temperature, a high leucocyte count and the appearance of a very distinct tumour. When the condition has lasted for a day or two there will very likely be a light jaundice. This is due either to the inflammation spreading to the common bile-

a case of jaundice, the gall-bladder is enlarged the cause is due to some condition other than stone impacted in the common duct. However, there are exceptions to this, as the cholecystitis may not have lasted long enough to render the gall-bladder rigid, so that enlargement can take place.

If the obstruction at the bladder neck remains for a considerable time, the bile is absorbed, and there remains, distending the gall-bladder, a mucoid material secreted from its walls (hydrops of the gall-bladder).

The distended gall-bladder forms a rounded swelling emerging from under the margin of the liver in the region of the ninth right costal cartilage. It is always hard because it is tensely distended. A groove can frequently be felt between the tumour and the liver margin. The gall-bladder lies close under the abdominal wall and, therefore, it is dull on percussion, its dulness being continuous with that of the liver. Only very exceptionally is the transverse colon dragged up by the omentum in front of the gall-bladder to form an area of resonance in this situation.

If a stone remains impacted in the common duct for any considerable time, infection of the duct above it always occurs, and in this way infection spreads up into the liver along the ducts, a condition which is called cholangitis. It is rendered evident by irregular rises of temperature accompanied by shivering attacks.

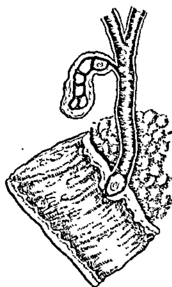
Cholangitis may lead to the formation of multiple abscesses in the liver. If the obstruction in the duct is complete the bile pigments and bile salts are absorbed from the bile remaining in the gall-bladder and ducts, which are left distended with a clear colourless fluid (white bile).

Stones in the gall-bladder or common bile-duct may also lead to inflammation of the pancreas, either acute or chronic.

The presence of gall-stones can sometimes be demonstrated by a simple X-ray photograph. Whilst cholesterin is transparent to the X-rays, calcium bilirubinate is opaque, so that as gall-stones are so frequently composed of a central area of cholesterin, surrounded by an envelope of calcium bilirubinate or calcium carbonate, an X-ray shadow in the form of a ring is obtained. Such annular shadows are diagnostic of gall-stones, but the absence of such shadows does not, by any means, exclude their presence. Disease of the gall-bladder wall is demonstrated by cholecystography. Tetraiodophenolphthalein is a chemical substance which is secreted almost solely by the liver. It passes down the bile-duct in the bile and so gains entrance into the gall-bladder. In the doses administered it does not reach a sufficient concentration in the bile to give a shadow by X-rays, but the normal water-absorbing power of the gall-bladder raises the con-

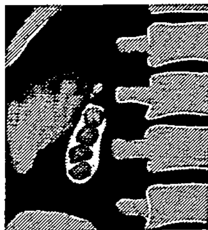
and has periodical attacks of biliary colic, the severe pain of which prostrates him. Patients who suffer from chronic cholecystitis and from gall-stones are as a rule middle-aged. They are frequently fat and feminine. They are usually married women who have had children, and are often indolent. Men are less frequent sufferers from gall-stones and the condition is quite uncommon in young people.

Biliary colic as a rule begins suddenly with intense pain in the region of the gall-bladder which spreads round to the back. It is one of the worst pains known, and at its maximum intensity causes collapse with sweating. It is due apparently to forcible contractions of the gall-bladder in an attempt to force a stone down the cystic duct or empty itself of its contents if the stone lies in the common duct. It therefore waxes and wanes. It lasts from four hours to a day or more, and may disappear quite suddenly with the passage of the stone, or perhaps a dropping-back of the stone into the gall-bladder. The pains pass off more gradually if the stone becomes impacted in the common duct. During the crisis the temperature may be raised and there may be a rigor. Within the next 48 hours a tinge of jaundice will appear. Should the stone become impacted in the common bile-duct this jaundice will not be evanescent but will increase in intensity until it becomes a deep yellow. With this jaundice there are itching of the skin, a great deal of nausea, clay-coloured stools because no bile pigment enters the bowel, and bilirubinuria. The jaundice which accompanies stone in the common duct varies in degree almost from day to day. This is because the inflammatory swelling of the mucosa may temporarily subside and allow a little bile to pass down the duct. This is an important diagnostic point because, if the obstruction of the common duct is due to a growth in the pancreas, there is no recession in the intensity of the colour, which becomes gradually and progressively deeper. Another important diagnostic point is the presence or absence of an enlarged gall-bladder. As a rule, when there is a gall-stone blocking the common duct there has been chronic cholecystitis for such a long period that the wall of the gall-bladder has become fibrous and inextensible. It cannot dilate. On the other hand, in carcinoma of the pancreas, or chronic pancreatitis, the wall of the gall-bladder is normal, and so this organ enlarges. Curvoisier's law states that if, in



Stone impacted in the ampulla of Vater. The gall-bladder wall *is thickened and fibrosed so that* the gall-bladder cannot dilate.

of colic abolished, but there is no upset noticeable by the patient; but should a gall-bladder be removed whose walls are more or less healthy and which has retained its concentrating function as shown by cholecystography, then the patient is apt to suffer from some digestive disturbances for some months after the operation: in fact until compensation has occurred. So that the more diseased the gall-bladder the more confidently can a cure be predicted. When a normal gall-bladder is taken away, there is at first a relaxation of the sphincter of Oddi: the bile trickles into the duodenum in a continuous stream. After a time, however, the tone returns to the sphincter and the extrahepatic ducts dilate. In the walls of the large bile-ducts there are sacculi called parietal glands, lined by cells similar to those found in the gall-bladder itself. These glands are very much more numerous in animals, such as the horse, which have no gall-bladder; and Sweet found that when the gall-bladder was removed from normal dogs, these glands hypertrophied very greatly, becoming racemose in nature. It is supposed that these parietal sacculi assume the function of the destroyed gall-bladder and concentrate the bile. This is how compensation for the loss of an important organ is brought about. It is not surprising then that if a gall-bladder which has retained its function is removed the patient suffers from digestive disturbances until this process is complete.



Cholecystogram: transparent gall-stones make clear areas in the shadow of the gall-bladder.

If it is necessary to operate for gall-stone colic when the patient *is old* or has some *intercurrent disease, it is sometimes advisable to* perform cholecystostomy instead of cholecystectomy. In this operation the gall-bladder is incised, the stones removed and a drainage tube left in the viscus for four or five days, or longer. This is a minor operation, but is not performed if conditions are favourable to cholecystectomy, because it has so often been followed by a recurrence of gall-stone formation. Moreover, if the function of the gall-bladder has been destroyed by disease, it is far better to remove it.

Operations upon the biliary tract in the presence of jaundice are associated with considerable risk. This is hardly surprising when it is remembered that the function of the largest gland in the body is disturbed. *The risks* are those of death from hepatic insufficiency, and, to a less extent, from haemorrhage. When the common duct is

centration (to the extent of 8 times) so that the gall-bladder contents become opaque. The drug is given by mouth on a fasting stomach. If a distinct shadow of the gall-bladder appears, it means that the concentrating function of the gall-bladder wall is unimpaired. If no shadow is produced, or the shadow is extremely faint, then either the gall-bladder wall is diseased or the drug has not been absorbed from the alimentary canal. In this latter case it will be seen in the X-ray plate. By this means the concentrating power of the gall-bladder is tested. The power of expulsion of its contents is demonstrated by giving the patient, whilst the shadow is most intense, a meal containing fat, usually in the form of cream. The fat, passing the pylorus into the duodenum, causes a normal gall-bladder to contract and empty, an action which can be demonstrated by taking further X-ray photographs. Cholecystography, introduced by Graham and Bell, is the most valuable test of gall-bladder function available. If there is a good shadow and it diminishes with the ingestion of fat, then the gall-bladder wall is healthy. The non-appearance of a shadow is almost as reliable evidence of a diseased gall-bladder wall. When there are gall-stones present in the gall-bladder, they may appear as clear spaces in the shadow obtained by cholecystography. More often the gall-bladder wall has lost its concentrating function when gall-stones are present, so that no shadow is obtained.



Skiagram of gall-stones.

The treatment of chronic cholecystitis is nearly always surgical. Operation is indicated for persistent intractable indigestion associated with tenderness on palpation of the gall-bladder and negative cholecystography, and for the presence of demonstrable stones in the gall-bladder if they are associated with indigestion or with attacks of colic. The mere presence of a stone in the gall-bladder without symptoms does not warrant an operation, as in this case the stone is single, composed of cholesterol, and the bile is sterile. For uncomplicated cholecystitis it has been found that the most satisfactory operation is that of cholecystectomy, that is, removal of the gall-bladder. The results of this operation are usually very good and particularly when gall-stones are present. When there are no gall-stones it is only justifiable to remove the gall-bladder when its walls are demonstrably pathological, as seen on the operation table. When a gall-bladder which has lost its function is removed, not only are subsequent attacks

by which a stone in this situation can be removed. By incising the peritoneum to the outer side of the second part of the duodenum this part of the alimentary canal, with the pancreas, can be reflected forwards and inwards, thereby exposing the lower end of the common bile-duct, which can be incised in this situation (retroduodenal choledochostomy). The other method of removing a stone is by incising the front wall of the second part of the duodenum and then cutting through the pancreatic wall in order to reach the stone (transduodenal choledochostomy). Both these operations are more serious undertakings than the supraduodenal procedure. They are serious because of possible injury to pancreas and the escape of pancreatic juice into the surrounding tissues, which causes necrosis and suppuration. Very exceptionally, when the condition of the patient will not allow of prolonged operation, a stone impacted in the lower end of the duct is allowed to remain, and a communication affected between the gall-bladder and either the duodenum or stomach. But when, as is usual, the stones are removed from the common duct and its patency established, the gall-bladder should be taken away. Drainage should always be provided after opening the common duct.

After operations for gall-stones or cholecystitis there is sometimes a return of attacks of biliary colic. One attack is very common during convalescence from the operation and it is attributed to the passage of a ligature on the cystic duct becoming free and passing down into the duodenum. When there are recurrent attacks after cholecystectomy, the presence of an overlooked gall-stone should be suspected, or, very rarely, the formation of a new stone in the common duct itself. However, gall-stones are not always present, in which case the attacks of colic are supposed to be due to a persistent cholangitis which causes the bile to become viscid and thick, so that its expulsion is difficult and painful. Such cases are difficult to treat, and a sufficient length of time should always be allowed to lapse before resorting to a second operation, because they frequently subside. If an operation is undertaken and no stone is found in the common duct and no other lesion in the neighbourhood, such as a duodenal ulcer, to account for the pain, then prolonged drainage of the common duct should be established. This is done by inserting a T-tube into the duct. This is allowed to remain for 8 to 10 weeks. The condition is usually cured by this means.

Fibrous Stricture of the Common Bile-Duct

This is almost invariably the result of damage to the common bile-duct during a cholecystectomy. There are many differences in the

blocked and the pressure is thrown back on the liver cells, the liver functions are disturbed, and the transformation of amino-acids into urea is seriously interfered with. If the further strain of the operation is thrown upon the metabolism of the body, the liver function may absolutely break down and the patient die with symptoms which resemble uraemia. The other risk, that of haemorrhage, is due to two things. First, the available calcium ions in the blood are diminished because they combine with the circulating bilirubin; and secondly, the liver being the source of prothrombin and perhaps fibrinogen, there is a deficiency of these substances.

Before operating upon a patient suffering from jaundice two or three days should be spent in preparation. The administration of glucose solution, by mouth or, if necessary, intravenously, is of the greatest assistance. It dilutes the toxins in the circulation and provides glucose which is easily assimilable by the liver cells. The calcium deficiency can be made good by 3 daily doses each of 5 c.c. of 10 per cent calcium chloride intravenously. To stimulate the liver to produce prothrombin vitamin K should be given by the same route. Since bile is necessary for its absorption by the alimentary canal there is likely to be a deficiency to be made good. Vitamin K can be given by mouth if bile salts be given with it.

In the presence of jaundice it is sometimes wise to relieve the pressure in the ducts by cholecystostomy and to postpone the removal of the obstruction of the common duct to a later date. This is particularly advisable if, on opening the biliary tract, white bile is found. A stone in the common duct may be impacted in the supraduodenal part of the duct or at the ampulla of Vater. The operation for removal of stone in these situations is designated choledochostomy. The surgeon usually detects the presence of a stone in the common duct by palpation. He inserts his index finger into the foramen of Winslow whilst his thumb rests on the anterior surface of the right margin of the gastro-hepatic omentum. When a stone has been discovered in the duct, it is removed, if possible, by an incision in the supraduodenal part (supraduodenal choledochostomy). If there are many adhesions and identification of the duct is difficult, so that there is some danger of confusion with the portal vein, such doubt may be set at rest by aspiration with a fine hypodermic needle. When the stone or stones have been removed from the duct its patency, as far as the duodenum, should be demonstrated by passing a bougie into that viscus. The hepatic ducts should not be overlooked in this search for stones. Sometimes the gall-stone is immovably fixed in the lower part of the common bile-duct, and by no effort can it be moved upwards into the supraduodenal portion. There are two operations

Quite rarely, biliary peritonitis is the result of an injury to the abdomen, in which case it is due as a rule to a rupture of the common bile-duct. The bile extravasated is sterile so that the condition may be present for a week or two before the symptoms become so serious that an operation is contemplated.

The treatment of biliary peritonitis is laparotomy, drainage of the abdomen through a suprapubic stab wound, and the removal of the gall-bladder or the drainage of the common bile-duct, whichever is at fault.

Torsion of the Gall-Bladder

Sometimes a gall-bladder is not sessile on the under surface of the liver but is provided with a double fold of peritoneum, so that it is possessed of great mobility. It may be so free that torsion can take place. If it does there is sudden colicky pain in the epigastrium or the right hypochondrium, associated with vomiting. There is tenderness in this region and very shortly after the onset of the pain a rounded tumour can be felt. The characteristic of this tumour is that it varies in consistency; at one time it may feel very hard and a few hours later very much softer. This is due to the fact that the twisting may partly come undone. There is no jaundice and the pulse and temperature may be normal for the first day or two or even longer, but if the torsion is so great that the circulation is endangered, gangrene comes on. This will give rise to signs of peritonitis, increased tenderness and rigidity, with a rise of temperature.

An operation is needed to undo the twist and remove the gall-bladder. The prognosis is very good if this is done within 48 hours of the onset, but after this the outlook is serious.

Abscess of the Liver

Abscess of the liver may result from an injury causing a haematoma which subsequently suppurates, from suppuration in a hydatid cyst, as the result of the dissemination of organisms by pus entering radicles of the portal vein, and as the result of the breaking down of an area of hepatitis in amoebic dysentery. The liver normally removes bacteria from the blood-stream so it is not surprising that a haematoma is very apt to suppurate. Pyaemic abscesses are nearly always multiple and occur as the result of such infections in the abdominal cavity as those associated with appendicitis. Quite unusually, a single abscess is found after appendicitis. The organisms which cause suppuration under these circumstances are staphylococci, streptococci or the *Bacillus coli*.

relation of the cystic duct to the common bile-duct. Sometimes a cystic duct is long; at other times the gall-bladder is almost sessile; or, again, the cystic duct may be adherent to the common duct and run parallel with it. Dragging on the gall-bladder to ligate the cystic duct may pull the common duct out into a loop which is included in the ligature. These patients have external fistulae persisting for a very long time. Ultimately the fistula closes, but this is accompanied by the onset of jaundice and a high temperature. If the stricture is not too narrow, some bile gets into the alimentary canal. There is only one treatment for this complication and that is to restore the biliary passages by some operative measure.

The procedure is always a difficult one because of the extensive adhesions which are invariably present. The longitudinal division of a stricture of the common bile-gut with transverse suturing only gives temporary success. If the narrow part of the duct is well above the duodenum, it may be possible to excise the stricture and suture the two ends of the duct together. If there is not sufficient room for this the hepatic part of the duct must be implanted into the duodenum or into the stomach. Very often the stomach must be used because it is more mobile and will reach the side of the divided duct more easily. There is a fair prospect of recovery and long life after this operation.

Biliary Peritonitis

This is an unusual condition in which there is an escape of bile into the peritoneal cavity without any apparent opening in the biliary tract. How the bile escapes from the gall-bladder is obscure. It was supposed that if pancreatic juice gained access to the gall-bladder, that gall-bladder wall became permeable to the bile, but the experimental evidence in support of this is not very convincing. It has also been suggested that the lesion is a microscopic perforation, perhaps due to inflammation at the extremity of a Lushka's crypt. Very likely infection plays an important part because more often than not stones are present in the gall-bladder. The condition is only seen in people over 50 years of age and the attack is of sudden onset and resembles very much the perforation of a gastric ulcer, though the symptoms are not so acute. There are tenderness and pain in the epigastrium with some rigidity, though this is not board-like in nature. The abdomen becomes distended, the temperature and pulse rate are both raised. The bile is a severe irritant to the peritoneal cavity so that large volumes of fluid are poured out, with the result that shifting dulness in the flanks can be detected. Jaundice comes on but it is mild in character and of late onset.

emetine hydrochloride, in grain doses intramuscularly, for 7 days. It is not possible at first to say whether the enlargement of the liver is due to hepatitis or to actual abscess. Under this treatment the liver will rapidly shrink in size if there is no more than a hepatitis. If there is an abscess present the contents should be evacuated by aspiration unless, when withdrawn, it shows that a secondary infection is present, when the abscess must be opened and drained.

When an abscess has ruptured into the general peritoneal cavity, operation is urgently required. The abscess cavity is exposed and a drainage tube inserted into it. The outlook is not very good, because if a secondary infection occurs the result is very often fatal.

Hydatid Cyst of the Liver

In 70 per cent of all cases of hydatid disease the cyst is in the liver. It is an endocyst and usually is on or near the inferior surface of the right lobe. There may be few clinical signs and no symptoms. A tumour in the abdomen may be discovered accidentally. If the cyst is very large, fluctuation and a hydatid thrill can be obtained. Large cysts give rise to a dragging sensation in the epigastrium. Pressure may produce symptoms of indigestion. Rupture can take place into the general peritoneal cavity, the result of which is generalised echinococcal disease of the peritoneum, and sometimes death from shock, or the disease may work its way through the diaphragm, and discharge itself into a bronchus. Suppuration in the cyst gives rise to the symptoms of liver abscess. The diagnosis is rendered certain by the complement deviation or intradermal test if antigen is available. There may also be an eosinophilia present in the blood and perhaps the patient may suffer from attacks of urticaria. An X-ray is sometimes helpful because calcification occasionally occurs in dead hydatid cysts, so that the nature of it becomes evident.

The treatment consists in exposing the cyst and enucleating it from the adventitious fibrous capsule which is formed around it by the liver substance. As it is a serious accident for the cyst to rupture and the daughter cysts to escape into the general peritoneal cavity, the parasite should be first killed by the injection of a few c.c. of pure formalin into the cyst before its enucleation. The cavity which results from the operation can sometimes be closed by sutures, but often must be packed round a drainage tube.

Rupture of the Liver

Rupture of the liver results from crushing injuries of the abdomen and is often associated with rupture of the spleen. It is a very fatal

The symptoms of abscess of the liver are some pain and distress in the hypochondrium, though these may be very slight, a temperature, intermittent in type with perhaps rigors, enlargement of the liver and tenderness with, on X-ray examination, a raising of the diaphragm. When an abscess of the liver is due to pyogenic organisms, aspiration with a needle should never be done, from fear of spreading the infection to the general peritoneal cavity.

When a single abscess is due to suppuration of a haematoma, infection of a cyst, or pyaemia, it should be opened and drained, if possible without entering into the general peritoneal cavity. This can usually be done by methods described for the opening of a subphrenic abscess. For multiple pyaemic abscesses of the liver there is no surgical treatment.

Tropical Abscess of the Liver is in a different category because it is not due to pyogenic microbes. It is the result of dysentery but, curiously enough, a number of cases occur in which there is no history of such an infection to be obtained. In these cases it is supposed that the infection has been confined to the caecum and the right side of the colon, so that there has been no diarrhoea.

Tropical abscess of the liver affects the right lobe far more often than the left. The condition often begins insidiously. The patient feels ill, loses strength and has an unexplained rise of temperature. Many of them suffer from attacks of sweating and the fever is intermittent. The appearance of the patient soon changes. He becomes thin and wasted, and his skin a greyish-yellow colour. The liver is enlarged to percussion and the enlargement may be so great that it causes some compression of the base of the lung. It does not, as a rule, project very far downwards. There may be signs of pleurisy at the base of the lung. The liver is tender on pressure. An X-ray is of help in showing the raised diaphragm. The enlargement is at first due to a hepatitis; only later does the inflamed liver tissue break down, apparently as the result of the action of ferments. The pus is of a characteristic chocolate colour and of a glairy consistency. The abscess may rupture into the general peritoneal cavity when the signs resemble very much those of a perforated gastric ulcer. Or very often it discharges into a bronchus, in which case the lung has become adherent to the diaphragm and the inflammatory process has spread right through from the liver into the lung tissue. This is an occurrence which is followed very often by a favourable outcome. The patient coughs up his abscess and recovers. Quite rarely, the liver becomes adherent to the anterior abdominal wall and the abscess actually ruptures on the surface.

The treatment of tropical abscess is first the administration of

enlargement of the gall-bladder or gradually increasing jaundice appears. The outlook for all patients with carcinoma of the gall-bladder is exceedingly bad although an operation may reveal the growth to be limited, and frequently the gall-bladder with a small piece of adjacent liver can be removed; yet recurrence is almost invariable, and from this the patient dies.



accident. There is severe shock, which is followed by the signs of internal haemorrhage. There are rigidity of the upper abdomen and tenderness in the liver region and inhibition of the diaphragm. It is the right lobe which is injured as a rule.

Early operation is necessary if the patient's life is to be saved. The tear in the liver tissue is sutured by inserting mattress stitches by means of a blunt-pointed liver needle. Sometimes it is impossible to stitch the wounded surfaces together when the only way of arresting haemorrhage is to plug the cavity. In these cases the plug is not effective unless the border of the liver is sutured to the anterior abdominal wall.

Syphilis of the Liver

Syphilis of the liver is important surgically because in the tertiary stage large gummata may develop and form nodules in the liver which are palpable. They occur ten years or more after the primary lesion. Large gummata may give rise to jaundice by pressure upon the hepatic ducts and there may also be attacks of colic. It is not possible always to differentiate between a secondary carcinoma of the liver and a gumma, but if the disease is suspected anti-syphilitic treatment will quickly make the diagnosis clear, because the gumma will disappear and the jaundice clear up.

Tumours of the Liver

Benign tumours of the liver are very rare. The only tumours that may be said to be at all common are angiomata, and these are usually small and without significance. However, there are a few recorded cases where large angiomata have been removed by a surgical operation.

Carcinoma of the Liver is, as a rule, secondary to some primary growth within the abdomen, though, if this is small, it may be very difficult to detect. Carcinomata in the liver form rounded masses which, owing to degeneration in their centres, contract and cause an umbilication on the surface. Very rarely, primary carcinomata of the liver occur.

Carcinoma of the Gall-Bladder appears in two types, the more common adenocarcinoma and the less common squamous-celled variety. Malignant disease of the gall-bladder is almost invariably associated with gall-stones so there would appear to be a causal relation between the two conditions. It does not cause any symptoms until it obstructs the cystic duct or, growing from the neck of the gall-bladder into the liver, presses on the h

enlargement of the gall-bladder or gradually increasing jaundice appears. The outlook for all patients with carcinoma of the gall-bladder is exceedingly bad although an operation may reveal the growth *to be limited, and frequently the gall-bladder with a small piece of* adjacent liver can be removed; yet recurrence is almost invariable, and from this the patient dies.

CHAPTER XXXIII

DISEASES OF THE PANCREAS

Acute Pancreatitis

This uncommon abdominal crisis is seen in middle-aged people who are very often fat and have suffered from indigestion, and especially in those who have gall-stones. Excessive beer-drinking seems to predispose to it. The origin of the disease is rather obscure. It appears quite clear that, essentially, the condition is due to an activation of the trypsinogen within the gland so that it becomes capable of attacking the parenchyma, killing and digesting it. Experimentally it has been shown that such activation can be brought about by the injection of bile into the pancreatic duct: or by the similar injection of duodenal juice. Kinase can also be obtained from bacteria and from the leucocytes of blood. It has therefore been suggested that, when there is a common opening for bile and pancreatic juice, obstruction of the ampulla of Vater by a gall-stone may allow bile to pass into the pancreatic duct. This condition of affairs has occasionally been found. It is also thought that a spasm of the sphincter of Oddi might act in the same way, such a spasm being due to irritating contents in the duodenum. The application of dilute hydrochloric acid to the papilla of Vater is sufficient to make the sphincter go into contraction. In 10 per cent of people the duct of Santorini, the accessory duct of the pancreas, is the main outlet for the pancreatic juice. Its opening into the duodenum is unguarded by a sphincter. In such cases, and also when the opening of the main pancreatic duct has been rendered rigid by a duodenitis, an increase of pressure within the duodenum, such as that set up by vomiting, might lead to a reflux of duodenal juice into the duct system of the gland, and so initiate an acute pancreatitis. Metaplasia of the epithelium of the ducts is fairly commonly seen in sections of the pancreas. It has been suggested that the heaping-up of epithelium may lead to obstruction with dilatation of the small ducts and acini behind it, and rupture of the distended acini, so allowing the escape

of trypsinogen into the tissues. In other cases, activation may be due to bacteria brought by the blood, and certainly it can come from haemorrhages in the pancreas itself.

In most cases the first change in the gland is an aseptic cell necrosis followed by extravasations of blood. Haemorrhage is such a prominent phenomenon that the resulting condition is called haemorrhagic pancreatitis. It is due to the destruction of the walls of arteries and veins by trypsinogen. When there is no haemorrhage but simply oedema, there occurs the much rarer oedematous pancreatitis. The addition of infection sets up a suppurative pancreatitis and usually gangrene.

Haemorrhagic Pancreatitis

Haemorrhagic pancreatitis begins with an acute attack of pain in the epigastrium which is persistent, but accompanied by spasms of greater intensity. The patient has a cyanotic appearance; his skin is cold and clammy; the pulse, which at first was normal in rate, becomes small and rapid; the temperature is only slightly raised; vomiting is continuous; the epigastrium is at first flaccid but soon becomes rigid, though not so hard as with a perforated ulcer; there is tenderness in the epigastrium and also perhaps in one or other of the costo-vertebral angles; glycosuria is uncommon; a curious sign which has been noted is a bluish colouring around the umbilicus.

Loewi's test is the instillation into the conjunctival sac of two drops of 1 in 1000 adrenalin. In acute pancreatitis the pupil becomes dilated and irregular. The test does not always come off; and it has been found positive in hyperthyroidism and in gall-bladder disease. In acute pancreatitis there is absorption into the blood of the amylolytic ferment so that there is an increase of diastase in the urine. The diastatic index, that is, the number of units of diastase in 1 c.c. of urine, may be 100, 200 or even 2000, whereas the normal range is from 6·7 to 33·3 units. If there is much shock there will be an elevation of the red cell count and haemoglobin, a low serum content of chloride, sodium and calcium.

In subacute pancreatitis, the illness begins as described above, but the symptoms abate. Though the temperature may fall, the pulse keeps rapid and small, whilst the rigidity in the epigastrium persists. Gradually a painful, tender tumour appears in the epigastrium, as large as a fist, or larger. Wasting is remarkably rapid; there may be glycosuria.

The diagnosis must be made from acute perforations of the stomach or duodenum, acute cholecystitis, high intestinal obstruction

and chest conditions such as coronary thrombosis, pneumonia and diaphragmatic pleurisy. Two things are notable in acute pancreatitis: the absence of pronounced rigidity in such an acute abdominal condition and the raising of the serum amylase which is absolutely characteristic.

In these serious cases the mortality is very high. First, shock must be combated by morphine, intravenous plasma and saline. Some surgeons hold that an operation is seldom necessary, but if the symptoms are acute and do not quickly recede in intensity it is better to operate. The abdomen is opened in the middle line above the umbilicus. There will be blood-stained fluid in the peritoneal cavity, and usually fat necrosis. The activated pancreatic juice, in addition to causing the death of the parenchyma of the gland, digests the fat in the neighbourhood and, escaping from the confines of the pancreas, attacks the fat in the omentum, mesentery and wall of the intestines. Yellowish-grey areas are found in all these situations. The lesser sac of the peritoneum is filled with blood; the pancreas is much enlarged with haemorrhages throughout its substance. The peritoneum over the gland should be slit up in several places, but the parenchyma should not be cut into. A large drain is brought out on to the surface of the abdomen. If gall-stones are present with a cholecystitis, the gall-bladder should be drained as well. Because of the likelihood of a subsequent septic cholangitis it would seem unjustifiable, for an acute disease, to perform a cholecystgastrostomy as recommended by some surgeons.

The rare form of pancreatitis in which there is simply oedema without any haemorrhage is treated in the same way; it is liable to be overlooked.

In the subacute variety there is often found a haematocele in the pancreas. This must be opened and drained.

Suppurative and Gangrenous Pancreatitis

This is really a complication of the subacute form in which infection has taken place. The symptoms abate temporarily, but then fever sets in with rigors; there is a leucocytosis; pain persists in the epigastrium, and there are often diarrhoea and steatorrhoea. A tumour forms in the epigastrium, but the pus may travel up under the diaphragm, or into the loin; wasting is very pronounced.

Steatorrhoea is a condition in which large fatty liquid stools are passed; when they cool, the faecal material in them sets solid into a plate which floats on the surface of an oily liquid. These pale-grey

bulky stools of extensive pancreatic disease may be composed of more than 50 per cent of fat.

In these cases operation is necessary to drain away the pus. If the pus presents in the loin, it may be evacuated here, but on the whole it is better to open the abdomen in the middle line above the umbilicus, as a view of the pancreas is obtained, and the extent of the damage becomes clear. By this route, sloughs can be removed and quite an efficient drainage brought about.

There are cases of suppurative pancreatitis in which infection is the primary lesion of the pancreas; they are very acute and all die, treatment being of no avail.

Attenuated Pancreatitis

Attenuated pancreatitis is a mild form of acute pancreatitis. There are pain in the epigastrium, and tenderness there and perhaps in one or other lumbar fossa. This pain is usually worse at the end of gastric digestion, and is accompanied by a feeling of fulness. Sometimes there is colic to the left of the middle line radiating towards the spleen. In the epigastrium the pulsation of the aorta is felt very distinctly over a wider area than normal. The condition may subside or go on to the formation of a pseudocyst.

Chronic Pancreatitis

This is a disease of middle life. Of the causation very little is known. It is supposed that infection may be secondary to that associated with gall-stones, or to a gastro-duodenitis; this latter is sometimes due to the presence of a diverticulum of the duodenum; syphilis and gall-stones without infection seem to play their part. The change in the gland is a fibrosis which is either interlobular or interacinar. Chronic pancreatitis is usually accompanied by jaundice, but occasionally this symptom is wanting. The interference with the secretion of the pancreatic juice leads to very pronounced dyspeptic symptoms: a constant discomfort in the epigastrium, flatulence, fetid breath, a strong aversion to fat or meat and sometimes to sugar; a chronic diarrhoea comes on, the stools being bulky, grey and oily; glycosuria is rare. The result of all this is that the patient wastes very rapidly. Although often a painless disease it is not invariably so; severe pain of a colicky nature which radiates to the left lumbar region occurs, and appears to be due to pressure of the enlarged gland upon the coeliac nerves. Another symptom seen in chronic pancreatitis is haemorrhage, from the nose, stomach, intestine, kidneys,

or into the skin. It is not usual to be able to feel a definite tumour, but in the wasted epigastrium region the pulsation of the aorta is very distinctly felt and indeed over a wider transverse area than normal. The jaundice is of the obstructive type without a rise of temperature, and with enlargement of the gall-bladder in 5 per cent of cases. Gall-stones are very often present, so that there may be attacks of biliary colic. The special *pancreatic tests*, described as occurring in acute pancreatitis, are not often of help in the diagnosis of chronic inflammation because they so frequently fail; however, they should be done.

Even at a laparotomy it is not always easy to be certain that a chronic pancreatitis exists if the surgeon can only judge of it by the feel. When, however, it is deemed to be present, some biliary drainage operation should be done. The most useful is a cholecyst-jejunostomy. Alternatively the gall-bladder may be anastomosed to the duodenum or stomach.

Cancer

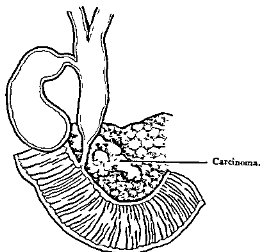
Carcinoma occurs in the head, body or tail of the gland. Its incidence in the head is far greater than elsewhere and in this situation it soon causes obstruction of the common bile-duct. It is seldom of great size and usually scirrhus in type. With the naked eye it is difficult to perceive its boundaries or to distinguish it from chronic pancreatitis. It causes death by its secondary pressure effects. Neither the bile nor pancreatic ducts are actually invaded by the growth but they are compressed so that they become totally obstructed. The islets of Langerhans are unchanged. Rather exceptionally invasion of the duodenal wall occurs. Because the patient succumbs early to his disease, metastases are not seen outside the regional glands.

The symptoms begin with a loss of appetite (especially for meat and fats) and nausea. Then occur attacks of vomiting and pancreatic diarrhoea (steatorrhoea), dry throat and constant thirst. Jaundice, which is usually the first sign in chronic pancreatitis, follows. It becomes progressively deeper without any remissions. Itching is almost intolerable. The cachexia which comes on is remarkable in the rapidity with which it develops. No cancer is capable of producing a wasting so quickly. The patient visibly loses weight almost daily. In a few weeks he is little more than a skeleton. Although the disease is said to be painless, at least one-half the patients complain of epigastric distress or pain which is constant or occurs in paroxysms. It never reaches the awful intensity of the pain of cancer of the body of the pancreas, nor is it as intense as biliary colic. The temperature is normal. There are no rigors as when a calculus is impacted in

the common duct. The liver is enlarged and the gall-bladder palpable in 85 per cent of cases. Usually the growth in the head is too small to be felt through the abdominal wall. As the disease goes on ascites and cachexial oedema of the feet and hands appear. Death usually occurs in four to six months.

The absence of the acute attacks of biliary colic, of fever and rigors, of remissions in the intensity of the jaundice, and the palpable gall-bladder together with the rapid onset of severe wasting, all help to distinguish the disease from a gall-stone impacted in the common duct. But sometimes, when there has been pain, the diagnosis cannot be made until the abdomen has been opened, and even then it may prove impossible to say whether the induration in the gland is due to a carcinoma or to chronic pancreatitis. As a rule all that can be done is to anastomose the gall-bladder to the stomach, duodenum or jejunum. This gives immediate relief to the itching, the jaundice goes and, if the condition was due to chronic pancreatitis, leads to permanent cure. Following these operations, an ascending infection of the gall-bladder and ducts seems to be rather rare, but how frequent it is cannot be readily computed as so many of the patients die within a short time.

When the growth is small it can be removed. The duodenum with the head of the pancreas is lifted off the vena cava. The superior mesenteric and portal veins are cleared in their whole extent. Then the neck of the pancreas is cut across, the stomach divided just proximal to the pylorus and the duodenum a little to the right of the superior mesenteric vessels. The common duct having been divided, the head of the pancreas and the duodenum can thus be removed. The stump of the duodenum is closed. The common bile-duct, the neck of the pancreas and the open end of stomach are implanted separately into a loop of jejunum. Sometimes the pancreas is just sewn over so that no pancreatic juice enters the intestine. In dogs this is fatal, but not so in monkeys nor, fortunately, in man. Neither does fatty infiltration of the liver occur as it does in dogs, a reminder that we must always be careful in



Carcinoma of the head of the pancreas, obstructing the common bile-duct. The gall-bladder is dilated.

applying the lessons of animal physiology to man. Some patients seem able to digest their food almost as well without their pancreatic juice as with it. In others there may be at times some difficulty with fats. It is said that this can be overcome by the administration by mouth of lipocaic, a preparation of pancreas which influences fat metabolism.

Carcinoma sometimes grows from the bile-duct at the ampulla of Vater, and rarely from the mucosa of the papilla. Such growths cause symptoms indistinguishable from those of carcinoma of the head of the pancreas. They cause trouble when they are very small, so it is not surprising that they have been removed from within the duodenum. An operation for internal biliary drainage should be done at the same time.

When carcinoma occurs in the body of the pancreas, there is no jaundice, but there are attacks of terrible pain in the epigastrium spreading round to the back which resemble very much the abdominal crises of tabes. There are the same digestive troubles as when the disease is in the head. A tumour is felt in front of the spine.

When the disease attacks the tail of the pancreas, it often forms a cyst which, situated here, can be removed.

Islet Cell Tumours

These are rare small tumours about 2 c.mm. in diameter, which grow in the body or tail from islets of Langerhans. There may be more than one present. They have the peculiar property of causing increased carbohydrate combustion. So the patient is subject to attacks of hypoglycaemia particularly after fasting or physical exertion. There are dizziness, nausea and vomiting. The patient becomes very pale, sweats and passes into convulsions. Or perhaps he shows mental confusion only, or becomes maniacal or goes into a coma. The diagnosis is made by precipitating an attack and, while it is on, estimating the blood-sugar. It is no more than 30-35 mg. per 100 c.c. of blood. The attack is usually brought on by withholding food and by making the patient exercise. Immediately the sample of blood has been obtained 100 c.c. of 5 per cent glucose are injected intravenously to cut short the attack.

These patients can be cured by removing the tumour, which is situated fortunately in the body or tail of the gland. If no tumour be found, the proper treatment is to cut across the neck of the pancreas and remove the whole of the organ except the head, because in these patients there is a hyperactivity of the islets of Langerhans.

Islet tumours have been known to form metastases. This is the only way such a tumour can be recognised as being malignant.

Injuries to the Pancreas

Severe injuries of the pancreas can scarcely occur without serious damage being done to other abdominal organs; thus the clinical picture is complicated.

In a less severe accident the pancreas may suffer contusion against the vertebral column. At the time there is abdominal shock but rigidity of the muscles is usually wanting. The symptoms all pass off and the patient is considered cured, when, after a few days or weeks, pain returns with vomiting and digestive troubles. Very soon there is wasting. A tumour can now be felt in the epigastrium, usually on the left side, perhaps as large as a fist; it is a haematoma. This tumour is dull on percussion but there is resonance above from the stomach and below from the colon. Violent pancreatic coeliac neuralgia may come on.

The treatment is the opening and drainage of the cyst. The results are good.

False Cysts.—After an accident sometimes the delay before the tumour appears is one of several months. Sometimes, indeed, there is no history of an accident at all. It appears that the injury to the pancreas causes a small area of the gland to necrose, which leads to a fistula into the lesser sac of the peritoneum. This cavity becomes filled with blood, exudation and the secretions of the pancreas. A very large cyst may be the result (pseudocyst). This has no proper wall of its own; it is an anatomical space lined with a layer of fibrin. It contains a clear yellow, brown or even black fluid in which can be demonstrated one or more of the pancreatic ferments.

These false cysts project between the stomach and colon, are fixed to the posterior abdominal wall, are very often somewhat to the left and are accompanied by great wasting.

They must be opened and marsupialised. A cure follows in almost every case.

Cysts of the Pancreas

Apart from polycystic disease which has no surgical interest, true cysts are very rare and usually either benign cystic adenomata or degenerated carcinomata. They occur far more commonly in the tail of the pancreas than in the other parts of the gland. They resemble very much false cysts, but are more movable, and, being in

the tail of the gland, are situated well to the left side of the epigastrium. They grow insidiously, but after some time begin to give rise to the pain of coeliac neuralgia. Of all cysts in the abdomen they are the most painful. One curious feature is that the volume of the tumour may vary in size. They can be pushed forwards from the loin against a hand on the anterior abdominal wall.

The treatment is removal of the cyst. This is often possible. At times it is best to remove the tail of the pancreas with the cyst. Marsupialisation is done when excision is impossible. It usually leads to the formation of a pancreatic fistula which will not heal.

Fistulae of the Pancreas

Fistulae occur chiefly after operations; particularly after gastrectomy or an operation for gall-stones; but they are also seen after operations for haemorrhagic pancreatitis, or the marsupialisation of a true cyst; they are not very common after a false cyst has been opened.

These fistulae are very troublesome because, owing to the activity of trypsin, the juice escaping causes ulceration all round the wound. This action can be only partly counteracted by neutralising the juice either with N/10 hydrochloric acid, or with sterile beef juice or peptone. Some protection can be given to the skin by ointments (page 387). Dry powdered kaolin is also very good.

As a rule a pancreatic fistula heals after weeks or months, so that no operation should be done until a long time has elapsed. The best procedure is to separate a length of the fistulous tract and sew it into the stomach.

Pancreatic Lithiasis

Pancreatic stones are very rare. They are composed of calcium carbonate, phosphate and oxalate. They are usually small and multiple and of course opaque to the X-ray. Just as a stone in the kidney leads to chronic interstitial nephritis, so stones in the pancreas cause chronic pancreatitis. Sometimes much fat forms round the gland. The duct of Wirsung is dilated. Gall-stones are often present at the same time.

Frequently there have been no symptoms and the stones have only been revealed by a radiograph made for some other purpose. But the stones may cause acute attacks of pain in the epigastrium (pancreatic colic). The pain radiates to the hypochondrium or the left loin. Transitory glycosuria may occur after the attack. Sometimes

there is jaundice either from accompanying gall-stones or chronic pancreatitis.

Should an operation be undertaken, it may be very difficult to palpate the stones within the pancreas; nothing else but a hard gland is perceptible. The stones are removed either by an incision on the front of the gland, or by one behind, after mobilising the duodenum and turning the pancreas forward.

CHAPTER XXXIV

DISEASES OF THE SPLEEN

THE surgery of the spleen is a rather restricted field because there is only one operation on the spleen which is technically possible: that is, removal of the spleen. So the surgery of the spleen resolves itself into those diseases of the spleen for which splenectomy is the remedy. Although the functions of the spleen have not been fully worked out, it is known that the organ is not indispensable. Changes take place in the body after splenectomy, but compensation follows. The immediate effect of splenectomy is the occurrence of an anaemia characterised by a number of reticulocytes. The red cells show an increased resistance to hypotonic salt solution. There are an increase in the number of platelets and a leucocytosis. A rise of temperature always follows the operation. The bone marrow shows a cellular hyperplasia, and with the appearance of this the anaemia goes. In the human being there is no evidence that there is a lessened immunity response after the removal of the spleen, although experiments have suggested that this is the case in animals.

Therapeutic removal of the spleen is indicated for—

Injuries of the Spleen.
Torsion of a Movable Spleen.
Acholuric Jaundice.
Thrombocytopenic Purpura.
Splenic Anaemia.
Aneurysm of the Splenic Artery.
Abscess of the Spleen.
Cysts of the Spleen.
Tumours of the Spleen.

INJURIES OF THE SPLEEN

The spleen is not very commonly injured, because it lies under the protection of the lower part of the thoracic cage. Lacerations occur as the result of forcible compression of the abdomen. Sometimes the organ is torn by the jagged fractured end of a lower rib on the left side. The degree of injury varies. There may be a large single tear running into the substance of the spleen, or multiple fissures separating it into several fragments. Quite rarely the spleen

is torn away from its attachments. On the other hand, the laceration may be subscapular, leading to the formation of a haematoma in the spleen. This haematoma nearly always ruptures on to the surface after an interval of a few days to a week.

A patient with a splenic injury exhibits at first the signs of abdominal shock. He is pale with a rapid, small pulse, he vomits as a rule and he lies rather lifeless, taking very little interest in his surroundings. As the shock passes off, however, the diagnosis of the injury may prove to be quite difficult. The pain is referred to the left hypochondrium but there may be no visible sign of external bruising. Neither may there be very pronounced muscular rigidity. When a rib is broken there will be tenderness at the site of fracture, extreme pain on breathing and more rigidity of the abdominal muscles. The detection of a fractured rib may distract the surgeon's attention from the more serious injury to the spleen. The patient's condition may not change very much for a few hours because clot formation takes place within the lacerated area and the haemorrhage ceases, but as, with the passing away of shock, the circulation gains in strength, bleeding is resumed. As the blood is poured out into the peritoneal cavity the pulse begins to rise and the usual signs of internal haemorrhage appear (page 21). Even at this stage there may not be much abdominal rigidity, but there is always an increase in the area of splenic dulness, which is due to the presence of large masses of clot immediately beneath the abdominal wall around the ruptured organ. If the loss of blood has been extreme there will be dulness in the flanks, which moves with alteration in the position of the patient. This, however, must be regarded as a late sign and must never be waited for as a confirmatory symptom. An increase of the pulse rate above 100 beats per minute betokens a very serious loss of blood. Rectal examination will reveal fulness in the recto-vesical pouch and perhaps tenderness here. The patient suffers from thirst, and the loss of blood is indicated by the pallor which gradually increases as time goes on.

The treatment of the condition is laparotomy and removal of the spleen. Even though the tear should be a small one it is not safe to suture the organ. Almost certainly the wound will reopen and haemorrhage reappear.

It has already been mentioned that sometimes a subscapular haemorrhage occurs after an abdominal injury which, itself, may not be very severe; falling against the back of a chair may be quite sufficient to cause such a lesion. The patient soon gets over the immediate effect of the injury and may carry on his work for a few days, but suddenly there arises an abdominal catastrophe. The distended

splenic capsule has ruptured and a large intra-abdominal haemorrhage occurs. This is the explanation of those cases of abdominal injury which have been examined by competent surgeons and have been allowed to return to their homes and resume work, and in which subsequent history shows that a splenic injury has been overlooked.

Splenectomy is best carried out through a left upper paramedian incision. It is very seldom indeed that this approach will not render the spleen accessible. In exceptional cases it must be supplemented by a transverse incision through the rectus muscle. After the spleen has been removed there does not seem to be any point in making any effort to remove the extravasated blood from the peritoneal cavity, as it will be absorbed naturally and leads to no harm. Blood transfusion may be required after the operation.

Torsion of a Movable Spleen

Sometimes, mostly in women who have had many children and have very thin abdominal walls, the pedicle of the spleen elongates so that the organ prolapses from its proper position in the left hypochondrium. It may become so movable that it can reach any part of the abdominal cavity, even the pelvis. It can usually be recognised because of its characteristic shape and its sharp, notched edge.

Such movable spleens are liable to torsion of the pedicle, when there will be severe pain accompanied by vomiting and the spleen will become much larger and tender. The proper treatment for this accident is splenectomy.

Acholuric Jaundice

This is a condition in which there is an anaemia accompanied by jaundice, not usually very intense, and an enlargement of the spleen. There is apparently an inherited defect in the red blood corpuscles. The disease certainly runs in families and it is usually said that there are two varieties, congenital and acquired. Some doubt, however, has been thrown on the suspicion that the disease is ever an acquired one. It seems to be always familial in type, although it may first appear in adult life.

A patient with this disease has a moderate jaundice and is subject to exacerbations when this jaundice is increased. At these times there may occur sudden abdominal pain, nausea, vomiting and a rise of temperature. The anaemia at these periods may be so increased that there may be no more than 1,000,000 red blood corpuscles per c.mm. of blood. After a time the exacerbation subsides and the

intensity of the jaundice recedes. The spleen is usually only moderately enlarged, though on rare occasions it has grown to a great size. The changes in the red corpuscles are the characteristic fragility to the haemolysing effect of hypotonic salt solution. Whilst normally the red cells do not break up until the percentage of salt has reached 0·30 to 0·45 per cent, in this disease the corpuscles may dissolve at a concentration of 0·5 to 0·7 per cent. There is a preponderance of macrocytes and spherocytes with numerous reticulocytes. The blood-platelets are normal in number and so are the white cells, although occasionally there is a leucocytosis. The bleeding and clotting times are also normal. The liver is usually slightly enlarged. Gall-stones which are made of bile pigment are found in 60 per cent of patients suffering from the disease. The marrow is hyperplastic, and blood-pigment is found deposited not only in the spleen but in the marrow, in the liver and in the kidneys. There is urobilin in the urine. Curious ulcers of the foot sometimes occur and the bones of the cranium may become thickened.

In mild forms of the disease no treatment is required, but when the anaemia becomes pronounced, and when serious exacerbations occur, then splenectomy should be recommended. It is a definitely curative surgical procedure in this disease. It causes the anaemia to disappear although there are still micro-spherocytes present in the blood afterwards. The patient recovers from his jaundice. Curiously enough, the resistance of the red blood corpuscles to hypotonic salt solution is unaltered. It is said that blood transfusions for this disease should be given after the operation and not before, because there is some danger of setting up a thrombosis in the splenic vein.

Since one-half of the patients with acholuric jaundice have gall-stones, the gall-bladder should always be examined when the spleen is removed. If there are stones present, and the condition of the patient allows it, these pigment stones should be removed. It is not necessary to excise the gall-bladder.

Thrombocytopenic Purpura

This is a condition in which haemorrhages occur from the mucous membranes, hence from the nose, the gums, the gastro-intestinal tract or the endometrium. Subcutaneous haematomata and bruises occur after very trivial injuries. There is a very great reduction in the number of blood-platelets, an average count per c.mm. being 40,000, whereas normally there should be a quarter of a million. The tendency to haemorrhage seems to depend on this deficiency of blood-platelets which are thought to be destroyed in increased numbers

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third stage anything up to two years, so that the disease is a very chronic one.

The general opinion is that splenectomy is advisable in this disease. It certainly seems to produce such a change for the better in young patients, and in the early stages that they may be regarded as definitely cured. In the late stages, where there is pronounced cirrhotic change in the liver, too much cannot be expected from splenectomy. The operation is based on the supposition that toxins are produced in the spleen and are carried to the liver, giving rise to the degeneration. This view of the pathology, however, is disputed by some observers who believe that the primary changes are in the liver. If this is so, splenectomy can only act by cutting off a large part of the blood-supply to the liver and so lessening the work it has to do. Attempts have been made to show that the prognosis of the disease is not bettered by splenectomy, but the change is so striking after the operation has been successfully performed that it is difficult to believe that this is a true picture of results.

Splenectomy in this disease is by no means always a simple procedure, owing to the fact that many adhesions may have formed between the spleen and the diaphragm, in which there are large anastomotic veins. Not only may it be difficult to separate these adhesions and deliver the spleen, but this act is accompanied by furious bleeding. Occasionally splenectomy is impossible, in which case ligation of the splenic artery is recommended. This is carried out by an approach through the gastrohepatic omentum. Blood transfusions both before and after operation are of great use in splenic anaemia. X-rays have no influence on the disease. The tendency to haemorrhage has been observed to return on rare occasions after splenectomy has been done.

Recently the view that Banti's disease is always primarily due to portal obstruction has led to surgical attempts to diminish the flow of blood to the liver. Thus the spleen and left kidney have been removed and the cut ends of their respective veins united over a vitallium tube. In at least two patients the splenic vein has been anastomosed to the side of the inferior vena cava, thus producing an Eck's fistula in man. The results are reported to be good.

Aneurysm of the Splenic Artery

This is a rare condition which is probably due to a congenital defect in the arterial wall. Most cases are only discovered at a post-mortem examination after rupture has taken place. In life there are only vague symptoms in the upper abdomen referred to the left side, but severe attacks of pain have been noted. The symptoms of rupture

within the spleen. There is no alteration in the calcium and fibrinogen content of the blood. The bleeding time is very much prolonged and may be increased to 30 or 60 minutes. If the circulation is cut off from a limb for a few minutes by an elastic bandage there appear petechial haemorrhages after its removal (tourniquet test).

Splenectomy brings about a cure in 80 per cent of patients. The change is immediate. The bleeding time within a few minutes of the operation may be reduced to under 10 minutes. The platelet count rises to normal or more than normal, but sometimes it subsequently falls to the level it was before the operation, though the tendency to bleeding is lost.

Splenic Anaemia

Splenic anaemia is the term given to an anaemia associated with enlargement of the spleen and subsequent cirrhosis of the liver. When this latter change has taken place it goes under the name of Banti's disease. It is seen as a rule in young adults, but occurs also in children. The spleen is enlarged, sometimes very greatly; it is fibrotic and frequently has adhesions to the diaphragm. The liver shows a cirrhosis in the later stages accompanied by a perihepatitis and ascites. There is varicose dilatation of the veins in the lower end of the oesophagus and of the veins connecting the vasa brevia with the oesophageal veins. Three stages are usually described. In the first stage, which lasts for five to twenty years, there is nothing but an anaemia with enlargement of the spleen. The red corpuscles are normal in contour but have only 50 per cent of haemoglobin. There is frequently a leucopenia with a relative lymphocytosis. The coagulation and bleeding times are normal. Urobilin may be found in the urine. The tourniquet test is sometimes positive. The symptoms are the vague symptoms of lassitude and depression which are caused by the anaemia. The enlarged heavy spleen may lead to a dragging sensation in the left side. The patient may discover the splenic enlargement himself.

In the second stage the liver is enlarged, hard and nodular. Portal obstruction is coming on. It is at this period that the anastomotic veins between the vasa brevia and the oesophageal veins are opening up, dilating and becoming varicose. They may give way and lead to a very serious haematemesis. In fact, haematemesis may be the first sign that the patient has of serious disease.

In the third stage the cirrhosis has become pronounced. There are present ascites, serious loss of weight and advanced anaemia. The second stage may last from a half to one and a half years and the

ruptured with the risk of disseminating hydatids throughout the peritoneal cavity.

Tumours of the Spleen

Benign tumours are exceedingly uncommon. Malignant tumours are *lymphosarcoma* and *secondary carcinoma*. *Curiously enough*, although the spleen has such an abundant blood-supply it is very seldom the seat of the growth of a secondary carcinoma.

Lymphosarcoma forms a large hard nodular enlargement of the spleen. It is a very malignant affection and although when possible the spleen should be removed, the prognosis still remains bad. X-radiation may be employed in inoperable cases.

are those of intraperitoneal haemorrhage as a rule. Rarely a splenic aneurysm becomes adherent to and ruptures into the stomach causing a profuse haematemesis. If the condition should be suspected and a laparotomy undertaken, the proper treatment is ligation of the splenic artery proximal to the aneurysmal sac.

Abscess of the Spleen

An abscess of the spleen is not a very common occurrence and is met with mostly in tropical or sub-tropical countries associated with malaria, dysentery, typhoid, hydatid cysts or, in some cases, with septicaemia and pyaemia, in which case there are multiple abscesses as a rule.

With an abscess of the spleen the patient is extremely ill with a high temperature. He usually has rigors. There are pain referred to the spleen which is due to perisplenitis, and tenderness in the right hypochondrium. The spleen as a rule can be felt enlarged. There is a leucocytosis. An X-ray will show the diaphragm pushed up and perhaps immobilised by the enlarged spleen.

The diagnosis may not be clear until the abdomen is opened, which should be done to the left of the middle line in the upper part. If the diagnosis is confirmed and the spleen is not adherent, splenectomy is the operation of choice. Successful results have been published. Very likely, however, the spleen will have become adherent, and in this case the abdomen should be closed and the abscess approached as in the operation for opening a posterior subphrenic abscess below the pleura. The general peritoneal cavity should not be penetrated.

Cysts of the Spleen

Occasionally large single cysts are met with in the spleen. They have no definite lining. Some of them undoubtedly are the results of a haemorrhage into the spleen but not always, because they sometimes contain a clear serous fluid. Multiple cysts also occur in the spleen, usually associated with multiple cyst formation in the liver and kidneys. This condition is not surgical.

The large single cysts cause the spleen to be so increased in size that it forms a palpable mass. This itself may lead to an exploration when splenectomy should be carried out. Suppuration in the cyst or rupture may occur as complications.

Hydatid cysts are also met with in the spleen. They also are best treated by splenectomy, great care being taken that the cyst is not

Very frequently such symptoms are associated with those of Cushing's syndrome seen in basophilic adenomata of the pituitary gland (page 149). That is, there are obesity of the face and neck, purplish coloration of the limbs, purplish lineae atrophae in the abdomen and thighs, hypertension and glycosuria.

In men with adrenal tumours the masculine characters are accentuated. In children there is precocious sexual development.

The diagnosis of an adrenal tumour with hormonal symptoms is not always easy because a very similar condition is produced by a basophilic adenoma of the pituitary or by that rare ovarian tumour the arrhenoblastoma, which has interstitial cells secreting androgens.

A skiagram of the skull may reveal an enlarged pituitary fossa, or a pelvic examination an ovarian tumour. An adrenal cortical tumour may be palpable in the abdomen, or it may reveal its presence by deforming the pyelogram or be actually visible in a simple skiagram after injecting air in the renal fossa. In adrenal tumours there is a greatly increased amount of androgens in the urine.

Should the diagnosis be established and the tumour or hyperplastic adrenal be successfully removed, the masculine symptoms will disappear and the normal state be restored. The best route for removal is through an upper paramedian abdominal incision. The presence of the opposite adrenal can then be determined and the blood-supply of the adrenal more easily controlled. Should symptoms of extreme shock follow, large doses of an active cortical preparation must be given.

Hypertension

In this serious disease surgery has been employed with, in some cases, at least a temporarily good result, though whether with ultimate prolongation of life it is not easy to say. The vascular narrowing appears to be due to a pressor substance released during renal asphyxia. A primary renal arteriolar spasm may be due to heightened nervous influences or the vessels may be peculiarly susceptible to adrenalin. A continued spasmodic contraction of the vessels may eventuate in a permanent structural narrowing. Surgery in this disease is based on the supposition that splanchnic section may relieve vaso-constriction of the renal vessels or affect them by cutting off the nerve-supply of the adrenals.

The splanchnics are divided above the diaphragm and the lower three thoracic ganglia of the sympathetic removed at the same time; or, perhaps preferably, the three splanchnics are divided on each side after they have passed through the diaphragm, the last rib having been removed to facilitate the approach.

CHAPTER XXXV

ADRENAL GLANDS

VERY rarely tumours grow from the connective tissue elements of the adrenal glands or from the sympathetic nervous elements of the medullary substance. Of greater clinical importance and frequency are enlargements due to activity of cells of the cortical zone. Such tumours of the cortex are hyperplasia, adenomata or carcinomata. Whilst a number of these tumours reveal their presence only as a lump in the abdomen accompanied by pain, others, very characteristically, give rise to hormonal symptoms. The normal adrenals produce both male and female hormones; more oestrogens in females, more androgens in males. When there is hyperplasia or tumour growth an excess of androgens passes into the blood-stream, leading to the appearance or increase of masculine characters. Only in rare instances are oestrogens secreted in excess with the consequent accentuation of female characteristics.

Both adenomata and carcinomata are usually rounded tumours of yellowish colour mottled with brown or red areas. The carcinomata are invasive locally and tend to destroy the adjacent kidney. Metastases appear in the liver and lungs; quite seldom in the bones. One very curious feature is that when a hyperplasia or a tumour discharges an excessive amount of androgen into the blood-stream the opposite normal adrenal is inclined to atrophy. So that when the offending adrenal and its tumour are removed the patient may die from acute adrenal deficiency.

In women the hormonal symptoms are very remarkable. There is an increased muscular development with a deepening of the voice. In growing children there is rapid growth at first followed by cessation, since premature ossification of the epiphyseal cartilages occurs. Hair grows on the face and body and very profusely in the genital region. It has a masculine distribution. The clitoris is enlarged and the labia swollen. Irregularity or cessation of menstruation occurs; in children menstruation may never be established and there is atresia of the vagina. The breasts atrophy; in children they do not develop. Acne appears on the face.

CHAPTER XXXVI

INTRA-ABDOMINAL TORSIONS

Torsion of the Omentum

In this condition the omentum becomes twisted on itself. The cause of the accident is unknown but it may occur suddenly after coughing or the attempt to reduce a strangulated hernia. Indeed 90 per cent of cases are associated with hernia or with adhesions of the omentum to viscera, the result of appendicitis.

The symptoms may be acute or subacute. Very often they are like those of appendicitis from which they cannot be distinguished. There are severe diffuse abdominal pain and vomiting. The omentum swells up and forms a tender mass perhaps slightly movable from side to side. Removal by operation is required.

Pelvic Torsions

An ovarian cyst, a stalked fibroid, the mass of a salpingo-oophoritis, or even a healthy ovary and tube sometimes undergo torsion. These cases present themselves in one of three forms:

(1) The patient has a sudden pain with collapse, rapid small pulse and low temperature. It looks very much as though there were an intraperitoneal haemorrhage.
(2) The case resembles one of intestinal obstruction. Great abdominal pain, repeated vomiting, arrest of the passage of faeces and gas, distension of the abdomen.
(3) There are signs of peritonitis which predominate. In every case peritonitis comes on after a time.

When an ovarian cyst is of any size it can be felt as a rounded mass below the umbilicus in the middle line. A small ovarian cyst or a distended tube may not be palpable from the abdomen but can be felt to one side of the pelvis by rectal or vaginal examination as a

The blood-pressure is certainly reduced in the early days after the operation, and headache, dizziness, thoracic pain and shortness of breath may be relieved. Success is more likely to be obtained in those patients in whom the blood-pressure is lessened by rest, sleep, sodium amytal or intravenous pentothal. If, under these circumstances, it approaches normal the result is likely to be good. In fact it is the early cases only which do well, as we should expect if the view of the pathology of the disease outlined above be the true one.

It must be confessed, however, that some careful comparisons of parallel series of operated and unoperated patients render it doubtful if surgery alters the course or prognosis of the disease.

CHAPTER XXXVII

ACUTE SALPINGITIS, ECTOPIC GESTATION AND HAEMORRHAGE FROM AN OVARIAN CYST

Acute Salpingitis

This disease is only mentioned here because it occurs as an abdominal emergency and comes under the notice of the general surgeon. The patient has *an attack of acute pain in the lower abdomen. There are* vomiting and a rise of temperature. The abdomen is tender in the lower part. The maximum points of tenderness are just above Poupart's ligament, and are present on both sides. These facts help to distinguish the condition from appendicitis. The muscles are not very rigid at first but of course they become so as the inflammation extends upwards from the pelvis. On rectal or vaginal examination great tenderness is felt on each side behind the uterus. There is the history of a discharge from the vagina either due to gonorrhoea or an infection after child-birth or a miscarriage. Such discharge will be present and recognisable.

If the diagnosis is certain it is better not to operate as most inflammations of this sort die down. When the peritonitis is spreading and the symptoms getting worse, or the diagnosis is in doubt, operation *should be done. With spreading peritonitis a drainage tube should* be left in Douglas' pouch. In other cases, the diagnosis having been established, the abdomen may be closed without drainage. Should the peritonitis be due to the rupture of a tubo-ovarian abscess, the pyosalpinx will need to be removed and frequently also the tube on the other side. Never remove both ovaries unless it cannot be avoided.

Ruptured Ectopic Gestation

This abdominal emergency also often comes to the notice of the general surgeon. Probably because of a preceding inflammation the ovum does not travel down the Fallopian tube into the uterus and fertilisation takes place within the tube. As the ovum develops it

tender mass. When on the right side there will be a great resemblance to appendicitis.

Operation is necessary and the outlook is favourable. The twisted ovarian cyst, Fallopian tube, or pedicled fibroid is removed.

Torsion of the spleen and gall-bladder, and volvulus of the stomach and intestine are considered elsewhere. (Pages 359, 376, 449, 466.)

CHAPTER XXXVIII

INFLAMMATORY DISEASES OF BONE

Bone, like any other tissue, consists of living cells with an intervening matrix, the only difference being that this matrix has been made rigid by the deposition of mineral salts. This rigidity, however, introduces some modifications into the pathological changes which take place in disease. Bone is of two kinds: compact bone which is found on the surface and is dense in structure and has only small Haversian canals traversing it with communicating canaliculi, and cancellous bone which is much more open in structure, containing marrow in its interstices, just as a compact bone has in the Haversian canals. Flat bones of the skull consist of two compact layers with a very thin cancellous layer in between. Irregular bones of the tarsus and carpus consist of a shell of compact bone with an interior of cancellous tissue. The shafts of the long bones consist of a tube of compact bone surrounding a central cylinder of marrow, whilst the ends have the same structure as the irregular bones, a thin periphery of dense bone surrounding cancellous network.

Repair of bone takes place by the formation of granulation tissue and the coalescence of opposing layers of such tissue. If there has been a solution of continuity the resulting fibrous tissue is laid down in lamellae of interlacing white fibres in which lime salts are ultimately deposited so that the bone is reproduced. Regeneration of bone takes place much more freely in cartilage bones than in membrane bones, so that we can get, for instance, replacement of bone in the lower jaw but not in the upper, and defects in the skull usually remain unclosed. When bone becomes inflamed there is an exudation from the vessels of fluid and cells as in the acute inflammation of soft parts, but, if the inflammation is at all acute, the pressure within cancellous spaces and Haversian canals may rise so much that the contained blood-vessels may be compressed, the circulation cut off and the bone die. Death of bone is called necrosis. Necrosis therefore takes the place of acute abscess formation in soft parts. When the irritation

gradually digests its way through the walls of the tube and at some time causes erosion of a blood-vessel leading to an intraperitoneal haemorrhage. If this be a large one there is a sudden very acute attack of pain in the abdomen, accompanied by severe shock. Then there appear all the symptoms and signs of a massive internal haemorrhage (page 21); with them there are tenderness in the lower abdomen and in the pouch of Douglas, which is felt to be distended with blood. The cervix uteri is soft to the touch and blood trickles from it. There is a history of one period having been missed. The volume of blood which can be lost from a ruptured ectopic pregnancy is immense; and it is astonishing how lifeless a patient may appear and yet recover. An operation is urgently necessary and it is unwise to wait for any amelioration of the symptoms, for as time goes on more and more blood is lost. Also it is usually better to withhold the blood transfusion until the haemorrhage has been stopped at the operation. This is very simple. Through a subumbilical paramedian incision the ruptured tube is removed. It can usually be recognised immediately by palpation as it is enlarged. No attempt should be made to suck away the large volume of blood in the peritoneal cavity for it will be absorbed and give rise to no trouble.

All cases do not proceed at once to a massive haemorrhage. There may be a small one which ceases, to be followed by another attack. Sooner or later a large haemorrhage occurs. In these recurrent cases the blood slowly poured out sometimes leads to the formation of a mass palpable either from the abdomen or from the pelvis. The prognosis after operation for ruptured ectopic gestation is good.

Haemorrhage from an Ovarian Cyst

Sometimes cyst formation takes place in a Graafian follicle or in a corpus luteum. Corpus luteum cysts are three times more common than Graafian cysts. A rupture of one of these cysts may lead to a very severe haemorrhage like that of a ruptured ectopic pregnancy. But there is no history of a missed menstrual period. An attack coming on at or after the middle of the intermenstrual period suggests a follicular origin; one just preceding onset of the menses is due to haemorrhage from a corpus luteum cyst. As in ruptured ectopic pregnancies the lower abdominal pain spreads upwards and is often felt in one or other shoulder.

The treatment is to resect the ruptured cyst and sew up the wound in the ovary. Milder haemorrhages lead to attacks of pain and tenderness just above Poupart's ligament with no muscular rigidity, no change in the pulse or temperature and general well-being.

the lower end of the femur would lose its characteristic shape. It would be pushed up the shaft by growth from the epiphysis at the top of a parallel-sided column of bone. The growth of bone and the maintenance of its rigidity depend upon the activity of some of the ductless glands, particularly the parathyroids. The bones are a source of calcium in the body. They act as storage sites for this element. If there is a deficiency of calcium in the food or if there is a deficient calcium absorption from the food, then the bones lose their rigidity, because a certain amount of calcium is being drawn from them every day to support normal metabolism and a certain amount is excreted. Vitamin D assists calcium absorption, so a proper supply of this vitamin is necessary for the growth of bones and the maintenance of their rigidity. In rickets there is deficient absorption of calcium from the alimentary canal. The calcium in the blood is low or normal, the phosphorus is diminished. In hyperactivity of the parathyroid glands there is a high percentage of calcium in the blood because the bones are induced to give up their calcium which is excreted by the kidneys. There is a low percentage of phosphorus in these conditions. The calcium is utilised by the osteoblasts by the aid of a ferment called phosphatase, so that, when there is deposition of bone, there must be a supply of phosphatase, a supply of phosphorus and available calcium salts.

Acute Osteomyelitis

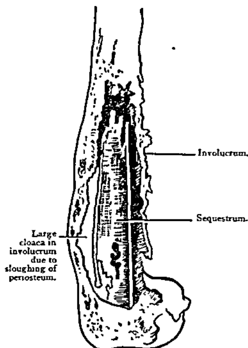
Acute osteomyelitis is a disease almost exclusively of childhood and adolescence. It is due to an infection of the bone by, as a rule, the *Staphylococcus aureus*. A few cases are due to the streptococcus and fewer still to the pneumococcus or the typhoid bacillus. In the common form due to the *Staphylococcus aureus* there is some primary septic lesion which may be a simple pustule of the skin. From this focus the organism gets into the blood so that every case of acute osteomyelitis begins with a bacteraemia. The organisms settle down in the end of one of the bones in the metaphysis, that is, on the shaft side of the epiphyseal cartilage. Just why the staphylococcus should attack the bone only and why it should select this particular region of the bone is not quite clear. Various explanations have been given which attribute the choice to the arrangement of the blood-vessels in this region, but these explanations are not very satisfying. It is worth noting that the part of the bone which is attacked is the recently deposited bone. Such tissue is perhaps more vulnerable to infection because it will not, as yet, have developed fixed tissue immunity.

Injury undoubtedly plays a part in determining the infection.

is not so acute and a chronic inflammatory process in the marrow takes place, there is always, at first, an absorption of lime salts. The Haversian canals or the cancellous spaces become enlarged by the erosion of their inner walls. This was, at one time, thought to be due to large multinucleated cells in the marrow, called osteoclasts, because they were frequently seen in little bays on the surface of the eroded bone, called Howship's lacunae. Some doubt, however, has been thrown on the absorptive activities of the osteoclasts. However this may be, in chronic inflammation of bone there is always a softening and a rarefaction of the bone at one stage. As the process continues and the intensity of the exciting agent diminishes, the osteoblasts of the marrow begin to line the enlarged spaces with new layers of fibrous tissue made of uncalcified lamellae of bone forming what is called osteoid tissue. The spaces thus become smaller by the laying down of this osteoid tissue which encroaches on them, and which is ultimately converted into rigid bone by the deposition within it of calcium salts. The affected bone may then become more dense than the surrounding bone, a process which is called condensation or sclerosis. If the rarefaction and absorption of lime salts is very widespread the bones may bend as in Paget's disease (osteitis deformans). In other inflammations, such as syphilis of bone, rarefactive processes go on side by side with sclerosis, the rarefaction occurring where the intensity of the irritant is greatest and the condensation at places more remote than the source of irritation. This increase in the density of the bone and the laying down of more bone on the surface is very prominent in syphilitic disease of the bone and in the chronic inflammation due to the staphylococcus. The tubercle bacillus, on the other hand, causes a rarefaction of bone but very little condensation occurs subsequently, so that the skiagrams of these diseases are very distinct from one another. In the two former there is great increase in density of the shadow, and in the latter there are more transparency of the bone and a loss of visible texture which looks almost as though the photographic plate had been fogged in one area. To inflammation of bone is given the general term osteitis. If the inflammation is confined to the surface of the bone we speak of periostitis. If there is a general inflammation of the whole thickness of bone, including the marrow, we speak of osteomyelitis. Repair of bone takes place exclusively from the marrow in the cancellous spaces and Haversian canals. It is very doubtful if any bone is ever laid down by the periosteum. The function of the periosteum is to limit bone formation and sometimes to cause bone absorption. During growth it moulds the ends of the bone. For instance, if the femur grew in length from its lower epiphysis without this activity coming into play,

round the bone may be separated from the shaft by a layer of pus, which portion of the shaft will necrose. The marrow within it will be liquefied into pus.

During this stage of the disease the patient is extremely ill and suffers from bacteraemia. Should he survive and get relief by the discharge of pus on the surface, he enters into a chronic stage. The necrosed bone irritates the adjacent living bone so that all round the piece of dead bone, which is called the sequestrum, there is a rarefying osteitis. Calcium salts disappear from the fibrous bone lamellae. The spaces are enlarged and filled with granulation tissue. This granulation tissue ultimately loses its connection with the dead bone so that the sequestrum becomes loose. At the same time that this is happening, in the bone which is next away in distance, there occurs a sclerosis. In the bone itself the cancellous spaces are filled up by the new formation of lamellae on their interior walls, whilst, from the deep surface of the periosteum, which was raised up by pus, surviving osteoblasts will cause a layer of new bone to form. This sheath of bone which now surrounds the sequestrum is called the involucrum, the holes in it corresponding to the original points of exit of the pus. The holes are called cloacae. So that the final result is the formation of a bony case, the involucrum, perforated by cloacae, which lead into this cavity lined by granulation tissue and containing a loose piece of dead bone, the sequestrum.

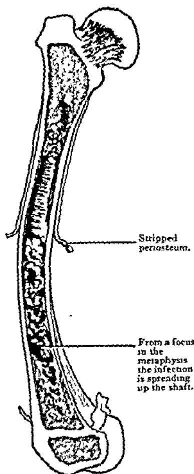


Acute osteomyelitis of femur: late stage.

Certain complications may occur. They are general or local. The septicaemia may cause the infection to begin in other regions of the body. Pyaemia may occur as the result of septic thrombosis of large veins within the marrow cavity and the dislodgement of the clot. The organisms in the blood may settle on the valves of the heart and cause malignant endocarditis. As local complications, we find the infection spreading to the joint causing a septic arthritis, or spreading right across the bone leading to separation of the epiphysis. Later on,

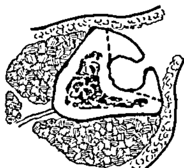
The history of a strain in the epiphyseal region is a very common prelude to the onset of osteomyelitis. Experiments have shown that, if there is a focus of non-infective inflammation set up by injury or chemical irritation, the capillaries in the affected region are more permeable to dissolved and particulate matter. Organisms injected into the blood in these conditions are found collected at the site of the inflammatory process. It has also been found that not only is the ingress of organisms into this area facilitated, but their escape is prevented. This seems to be due to a mechanical block of the draining lymphatics by deposited fibrin. So that it is easy to see how a strain at the epiphyseal junction might determine the onset of a staphylococcal infection at this point, were such microbes already in the blood-stream.

The result of the deposit of the organism in the cancellous spaces of the metaphysis is that an acute inflammation occurs in the marrow in this situation, and the spaces become tightly packed with leucocytes and serous exudation. So great is the pressure produced by the inflammatory secretions from the capillaries that it may rise above that of the blood-pressure, stop the circulation and lead to necrosis. Because bone is so rigid and inextensible, an acute abscess cannot form within it. Its place is taken by an area of necrosis. The focus of infection in the metastasis spreads towards the surface, usually laterally. When it reaches the periosteum it is prevented from spreading towards the articular region of the bone because of the attachment of the periosteum to the epiphyseal line. We therefore find an inflammatory reaction with the formation of pus which strips up the periosteum in the direction of the shaft. This subperiosteal abscess will in one or more places point through the periosteum, reach the soft tissues and perhaps form an abscess which actually opens on the skin surface. Extension from the original focus may also take place through the bone and reach the medullary cavity. Once it infects the marrow it will quickly spread from one end of the bone to the other. The result is that over a certain area the periosteum all



Acute osteomyelitis of femur: early stage.

it takes all this time for the metaphysis to become sterile. The thrusting of the needle through the cortex into the spongy bone relieves tension and allows of pus being aspirated. Some surgeons administer the penicillin through a metaphyseal needle so as to maintain a high concentration of penicillin where it is most needed. The old treatment of guttering the bone or even simple drilling is unnecessary. No large sequestra form. A subperiosteal abscess may need opening but the bone is not touched. Small sequestra may form but they have been observed by X-rays to be absorbed.





Obliteration of a cavity in the tibia by reflection of the soft tissues, removal of the overhanging bone edges (saucerisation) and the pinning down of the flaps with nails.

During treatment the limb should be immobilised in a splint. Should the neighbouring joint become infected it is aspirated and subsequently injected with penicillin, a treatment which will have to be repeated.

After the old methods of treatment, the patient was often left with a bone cavity lined by granulation tissue. If this cavity is of any size it will never fill up with granulations and heal by itself. The reason for this is that granulations can never reach more than a certain thickness owing to the fact that the deeper, first-formed granulation tissue becomes changed into fibrous tissue which, contracting, constricts the vessels which nourish the superficial layers. So that an individual with a bone cavity will retain this cavity until the end of his life. It may, indeed, cause his death by the chronic sepsis with which it is associated, setting up amyloid disease. Attempts have been made many times to fill these bone cavities as a dentist fills decayed teeth and always they have been unsuccessful, as it is not possible to get rid of infection in the walls. There are two ways in which the cavity can be obliterated. If it is changed from a deep hole with overhanging walls into a shallow depression (saucerisation), the soft tissues in the neighbourhood can be brought into the cavity and healing will occur. On the subcutaneous surface of the tibia this simply means that a flap of skin and subcutaneous tissue is pinned down to the surface of the now shallow depression. When the cavity is very near the epiphyseal line, as it often is in the upper end of the tibia, it is not possible to make a shelving edge for this would open into the knee joint. Under

interference with the epiphyseal cartilage may slow the growth of the limb or cause it to be deviated by inhibiting growth on one side only. In some cases a mild continuous irritation causes increased activity of the epiphyseal cartilage and so an increase in the length of the limb. A pathological fracture may occur as the result of weakening of the bone.

Symptoms and Signs.—Acute osteomyelitis is fortunately becoming an uncommon disease. This must be attributed to the improvement in the nutrition of the children of the country. It affects particularly poor, ill-nourished children, brought up under unhygienic conditions. It begins acutely with a high temperature and perhaps a rigor. The child soon complains of severe pain referred to the end of the bone, though sometimes he will say it is in the joint. The bone becomes exquisitely tender, and a careful examination will show that the tenderness is limited to a point just on the shaft side of the epiphyseal line. The commonest regions to be affected are the lower end of the femur and the upper end of the tibia, but no bone is immune from attack. Children with osteomyelitis are delirious at night and have a peculiar cry which is very much like the cry of a child with acute meningitis. After a few days redness of the skin may occur and a swelling, which indicates that the pus has reached the surface and broken through the periosteum into the soft tissues.

The X-rays are no help in diagnosis as there is no alteration in the shadow for from 5 to 10 days. When the bone marrow has been extensively destroyed there may be lipuria.

Treatment.—The course of the disease varies very much. There are some cases, fulminating cases, for which no treatment seems to be of any avail. If the blood of these children be taken there will be found to be 100 or more colonies of staphylococci to be grown from a single cubic centimetre. The necrosis of the bone takes place with extraordinary rapidity. The patient is extremely ill and dies from a septicaemia within 5 or 6 days. No treatment is of any use. These cases must be accepted as being beyond surgical assistance in the present state of knowledge. With the advent of penicillin the treatment of acute osteomyelitis has been completely changed. In all but the fulminating cases this drug will cause the systemic infection to clear up and the local lesion to become circumscribed. Continuous intramuscular administration of penicillin is best: 400,000 units should be given the first day, 200,000 units the second day and 100,000 units on subsequent days. The treatment will need to be kept up for 14 days at least. By inserting a sternal puncture needle into the metaphysis at the site of the infection, samples for bacteriological examination have been obtained, and it has been proved that

serous fluid will be found under the periosteum. The evacuation of this is sufficient to cure the patient.

Septic osteomyelitis sometimes attacks adults. It is particularly likely to attack those who have had osteomyelitis in childhood. In *children it is not very uncommon to find the disease begin in one bone* and spread through the blood-stream to another. The organism which is responsible appears to acquire a predilection for growing in bony tissue, and it also appears to be capable of remaining quiescent for a very long time, often many years, so that in subsequent life it *may be responsible for inflammation of the bone in its neighbourhood* or attack another bone. The recurrence of osteomyelitis around the original site is common. Sometimes adults suffer from acute osteomyelitis when there has been no primary attack in childhood. In any case, in adults, the disease shows no special disposition to go to *the bone ends. It will attack any part of the shaft. There is no* difference between the ends and the middle portions of the bones in adults. They are both composed of fully grown tissue. The disease is never so acute in adults, but is accompanied by very *great pain which may last for weeks, and is associated* with sclerosis with thickening of the affected bone.



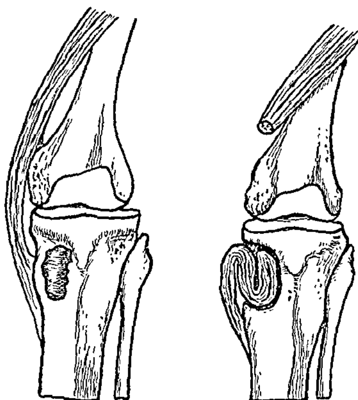
Skiagram of chronic abscess of humerus. Note the surrounding sclerosis and periosteal thickening.

Chronic abscess of bone is another manifestation of osteomyelitis in adults. It was described by Benjamin Brodie. Some bony abscesses begin primarily in the adult: some have their origin in an attack of osteomyelitis in childhood. The common sites for them are the lower end of the femur and the upper end of the tibia, but they may appear in almost any bone. The patient complains of pain, worse at night, which may continue for weeks or months. There are a slow gradual thickening of the bone in the neighbourhood and tenderness on palpation. There may be effusion of fluid into the near-by joint. As the inflammation is chronic in nature it is possible for the rigid bone to be absorbed to form an abscess cavity. Around this site of very intense inflammation there is very great sclerosis. So dense may the bone become that it may be difficult, or impossible, to see the cavity in an X-ray photograph.

The osteomyelitis of adults usually subsides under a course of penicillin. Whether a Brodie abscess will be sterilised or not experience will decide. But if there is very great pain it may still be

these circumstances, as much as possible of the cavity is dealt with in this way whilst the upper remaining part, with possibly an overhanging edge, is filled with an attached graft of living muscle. The muscle which is most convenient to use for this purpose, because its loss interferes so little with function, is the sartorius. It may be cut across at any distance up the thigh and turned downwards so as to fill the offending cavity.

The invention of chip grafting has provided another way of obliterating these cavities which has met with some success solely



The obliteration of a cavity in the upper extremity of the tibia by filling it with the lower part of the sartorius.

because of the assistance penicillin gives. The patient receives a course of systemic penicillin. Then his bone cavity is cleaned out and the walls gently scraped. Bone chips obtained from the ilium (see page 568) are packed into the cavity and the wound completely closed, a plastic flap being used if necessary. Penicillin treatment must be continued after the operation. The cavity is gradually obliterated by bone.

Occasionally a milder form of osteomyelitis occurs. It is called *Albuminous Osteomyelitis* and results from infection with the *Staphylococcus albus* and, more rarely, from the streptococcus. The symptoms and signs are all of a much milder degree and at the operation a muco-

tissue of the short bones of the fingers, or the irregular bones of the carpus and tarsus. In every case the marrow in the cancellous spaces is changed into tuberculous granulation tissue. There is, too, absorption of lime salts and, so characteristic of the disease, the transformation of the bone into a fragile structure, light in weight, suggestive of worm-eaten wood. As a rule, tuberculous osteitis spreads until it reaches the neighbouring joint, either one of the large joints or the small joints of the foot or wrist. Isolated tuberculous osteitis, without joint invasion, can occur in, for example, the great trochanter or the phalanges or metacarpals (tuberculous dactylitis).

Tuberculous dactylitis occurs especially in children and results in a fusiform swelling of a finger or a metacarpal bone. There is no pain but the finger becomes stiff. It is white in colour with no inflammatory reaction. The phalanx is eaten away by the tuberculous process and a cold abscess will frequently form on the surface. Sometimes, here, the disease will spread to the interphalangeal joints. In the treatment of tuberculous dactylitis, besides general treatment, the finger must be absolutely immobilised and it is best to do this in plaster of Paris. The position of the affected finger should be one of slight flexion, as this is a more convenient position to have the finger in than straight, should it become stiff. It is said that the incidence of pulmonary disease following tuberculous dactylitis is rather high. Therefore, when a finger has been considerably affected by the tuberculous process, it is advisable to amputate rather than institute a long period of splinting.


Tuberculous dactylitis.

A rare form of tuberculosis of bone is the chronic abscess. In this a cavity forms within the substance of the metaphysis of one of the long bones which resembles, both in symptoms and in clinical signs, very much the septic Brodie abscess. The abscess is surrounded by a dense bone which is not seen in other forms of tuberculous osteitis. The cavity is lined by a layer of tuberculous granulation tissue and is filled with tuberculous pus, or it may contain a rarefied cancellous sequestrum.

Caries sicca is the name given to chronic tuberculous osteitis, met with particularly in the upper end of the humerus and spreading to the shoulder joint. In this form of tuberculous osteitis the granulation tissue tends to become fibrous rather than caseate.

necessary to relieve the patient by making a number of drill-holes into it.

A rare form of osteomyelitis is that which follows an attack of typhoid fever. It occurs most characteristically about the third or fourth week during convalescence but may appear much later. An area of the tibia, the femur, the ribs, sternum or some other bone becomes painful and tender and a swelling appears on it. As a rule this area softens and forms a subperiosteal abscess containing the typhoid bacillus.

Quite rarely a similar form of osteomyelitis occurs due to the *Bacillus coli*. A simple incision of these subperiosteal abscesses suffices for their cure.

Tuberculous Disease of Bone

The tubercle bacillus may infect the periosteum of the bone (tuberculous periostitis), or settle down in the interior of the bone (tuberculous osteomyelitis). Tuberculous periostitis is seen particularly in the membrane bones, such as the flat bones of the skull, the malar bone and upper jaw, in the ribs, or in the sternum. In tuberculous periostitis there is a slowly forming swelling on the bone, which is quite painless, shows no signs of inflammatory reaction round about and eventually softens to form a fluctuating mass. These cold abscesses are found on the surface of the skull, particularly in young children. Ultimately the process may invade the bone and reach the dura. It is characteristic of all forms of tuberculous osteitis, except the rare chronic abscess of the long bones, that there is a disappearance of the bony structure with no increase of bone formation: rarefaction without sclerosis: so that the X-rays demonstrate a loss of substance of the bone and no increase of density surrounding it. In the case of the ribs, where a cold abscess forms, care must be taken to make certain that it does originate primarily from the rib itself, for an abscess coming from the spinal column may track round within the thoracic wall and come to the surface where the lateral or anterior cutaneous nerve branches perforate the muscles.

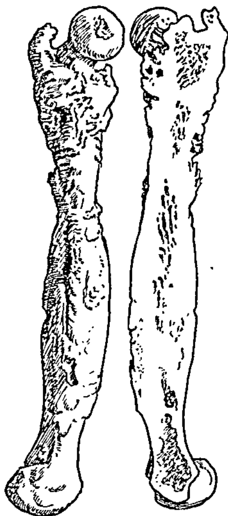


A tuberculous cavity in the lower epiphysis of the femur.

These cold abscesses are treated by aspiration, repeated if necessary. If the disease begins in a rib the best plan is to remove the affected part of the bone.

Tuberculous osteomyelitis begins either in the ends of the diaphysis or in the epiphyses of the long bones or in the cancellous

centre of the shaft of a long bone. Like the periosteal gumma, it will cause a great deal of pain which is worse at night and is likely to erode the bone to so great an extent that a pathological fracture results. A gumma of the shaft of a long bone will show by X-ray a central area of rarefaction and a wide surrounding area of dense new bone formation, where the irritation from the organism is less intense.



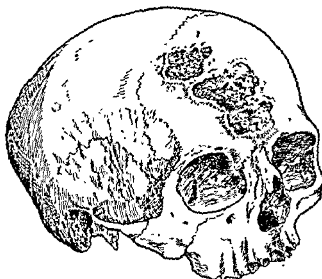
A syphilitic femur, split longitudinally. On the left the outer irregular surface: on the right the cut surface showing the great sclerosis and the filling up of the marrow cavity with dense bone.

The generalised form of syphilitic periostitis causes an irregular uneven surface to the subcutaneous bone which is very tender on palpation and very painful. The generalised form of osteomyelitis results from the spirochaete growing in the medullary cavity and the cancellous spaces throughout the bone, forming syphilitic granulation tissue which usually goes on to the formation of bone. The whole shaft becomes very much thicker and more irregular, heavier and denser, and the marrow cavity may be completely obliterated by the new formation. In hereditary syphilis the tibiae may actually show a curve which is usually confined to the anteroposterior plane. But in the adult there is a deceptive appearance of curvature, due to the deposition of bone, greater in the middle of the shaft than at the extremities.

The treatment of these bone conditions is the treatment of the primary disease. Sometimes, however, the pain is so intense that drilling may be called for to relieve tension and thereby alleviate the pain.

Syphilis of Bone

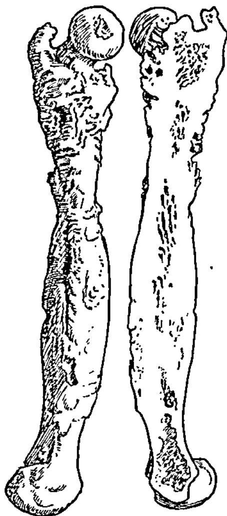
The *Spironema pallida* may settle in the deeper layers of the periosteum or in the medullary cavity or cancellous spaces of bone, giving rise to syphilitic periostitis or syphilitic osteomyelitis. The bones affected by syphilis are the flat bones of the skull, the palate, the nasal septum and all the long bones, particularly those which have a subcutaneous surface such as the clavicle, the sternum, the ribs, the tibiae and the ulnae. Whether the disease begins on the surface of the bone or in its depth it may be localised or diffuse



Gummatous ulceration of the skull.

in character. The localised form of syphilitic periostitis is called a node. These periosteal nodes are spherical masses of syphilitic granulation tissue which form from the deep surface of the periosteum and are found on the surface of subcutaneous bones. They cause great pain, particularly at night, and are very tender. A syphilitic node may resolve and the bone return to its normal shape; or, like a gumma in any other part of the body, may break down to form an *ulcer with a wash-leather slough with steep sides and a circinate edge*; or it may ossify and be transformed into a permanent bony nodule. By the X-ray the periosteal gumma will be found to have eaten away the surface of the bone and to have caused a zone of dense sclerosis around it. In the cases of the flat bones of the skull the syphilitic process may occur on the inner side of the bone and cause severe headache, and perhaps, by pressure on the brain, cerebral symptoms. In the case of the palate or the nasal septum, the gumma may penetrate right through the bone, caseate and leave a perforation. The localised form of syphilitic osteomyelitis is a gumma which develops near the

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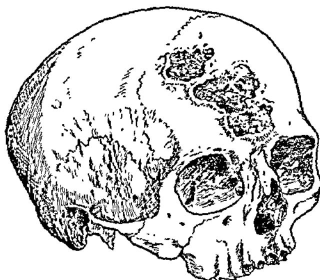
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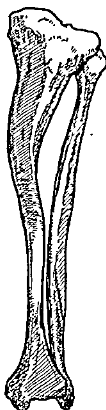
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becomes slender and the surfaces flat. The ends, however, are enlarged. This is spoken of as enlargement of the epiphysis, but the enlargement occurs really in the diaphysis, close to the epiphyseal line. The essential changes are an irregularity in the calcification of the cartilage, an increase in the cartilaginous zone and the transformation of this cartilage into soft osteoid tissue instead of into the normal rigid bone. This zone of soft tissue bulges laterally owing to the contraction of the muscles which pass over the neighbouring joint, forcing the bones together. This enlargement of the epiphysis is seen particularly in the case of the radius and where the costal cartilages meet the ribs. Clinicians refer to this as beading of the ribs and to the swellings at the ends of the bones as enlargements of the epiphyses. The femora also bend and so do the other long bones. Very frequently there is a pronounced kyphosis of the spine or, if the child is habitually carried on one arm of its parent, there is likely to be a scoliosis. The ribs are so soft that a deformity may occur in the form of a groove round the lower part of the thorax at the attachment of the diaphragm, due to the contraction of this muscle.


Rachitic tibia and fibula.

Owing to improved conditions of life in this country, rickets is becoming quite a rare disease. It is very easily cured by prescribing a proper diet containing fresh milk, green vegetables and potatoes. The child should also have plenty of fresh air, and sunlight should have access to his skin, because the ultraviolet radiation of the sun will change the ergosterol in his skin into vitamin D. At the same time, the limbs, if necessary, should be splinted to prevent deformities occurring until the bones have again become rigid. In the case of the legs a simple wooden splint should be applied to the outer side, a splint which reaches about 6 inches beyond the soles of the feet. This will prevent the child from bearing its weight on its lower limbs and effectively stop any further curvature. Should the child learn to walk on these splints as on a pair of stilts, it can be simply frustrated by tying the extremities of the splints together. The diarrhoea or


Genu varum. The curvature of the tibiae is most pronounced in the lower third.

CHAPTER XXXIX

NUTRITIONAL DISEASES OF BONE

RACHITIS

RICKETS is a disease due to malnutrition associated with bad hygienic conditions. It occurs particularly in babies from 6 months to 2 years of age. Changes similar to infantile rickets may occur much later in life, particularly during the period of adolescence. In this disease there is a deficient absorption of calcium salts due to the lack of vitamin D in the alimentary canal. As a result of this, the growth of bone is interfered with and the calcium content of the bone is diminished to supply that calcium which the body needs to replenish what is lost by excretion in the urine and the faeces. There is usually a deficiency of calcium in the blood whilst the phosphorus in the plasma is normal, or low in quantity. There is a definite favourable ratio between the quantity of calcium and the quantity of phosphorus in the contents of the alimentary canal. If there is too much phosphorus the calcium is precipitated as tertiary calcium phosphate and so it is excreted and lost. One element in the cause of rickets is this disturbance of the calcium-phosphorus relation which comes into play as well as the deficiency of the vitamin D which is necessary for the absorption of both elements.

A child with rickets shows general disturbance of health. It becomes listless and fretful. It perspires profusely at night, particularly over the scalp. Its abdomen is often distended and it has diarrhoea. The liver and the spleen are enlarged. The most characteristic changes occur in the bones. The head is relatively increased in size because there is stunting of growth of the trunk. It becomes square in shape with a rather overhanging frontal region. Sometimes there are thin patches in the calvarium (cranio-tabes). In the limbs the softened tibiae sag into a curve as the child sits cross-legged. The main convexity is outwards in the tibia but there is always a forward curvature as well. It is characteristic of a rickety tibia that it is bent in two planes. The shaft of the bone itself

The treatment of this condition is really the treatment of the underlying renal disease. Sodium bicarbonate may correct the acidosis and is of some use.

Osteitis Fibrosa Cystica Generalisata (Von Recklinghausen's Disease)

This is a disease in which there is decalcification of the bones, the transformation of the marrow into fibrous tissue, the formation of numerous cysts in the bones and sometimes the appearance in them of brown tumours. It is a disease which is associated with increased activity of the parathyroid glands (hyperparathyroidism). The primary result of this activity is an increase in the excretion of phosphorus. In order to bring the phosphorus in the blood up to its normal level the bones disintegrate and, in doing so, calcium is thrown into the blood. Thus there is brought about an increase of calcium in the serum and a diminution of the phosphorus in the plasma. There is an increase of calcium and phosphorus in the urine and also of the phosphatase in the blood. *In addition to the multiple cysts* in the bones there are the deformities due to bending of the soft skeleton: kyphotic spine, deformed pelvis, indrawn ribs. Very often there are pathological fractures and the long bones are bent into most unusual shapes. Since fibrous tissue has taken the place of the marrow there is sometimes an anaemia associated with a leucopenia. The brown tumours are osteoclastomata. The increase of calcium in the blood may be followed by its deposition in the kidneys so that renal calculi are found. Indeed, some cases of hyperparathyroidism are characterised not by changes in the bones but by the symptoms of renal calculi. Patients who suffer from hyperparathyroidism lose *their appetite, have nausea, attacks of vomiting and complain of pains* in, and tenderness of, the bones, in which there are frequently swellings. Owing to the need for getting rid of a great deal of calcium in the blood there is a polyuria, and this in turn leads to a polydipsia.

The X-ray shows numerous cysts in the different bones of the skeleton and a stippling of the intervening portions of bone. There may be also the typical appearance of an osteoclastoma. The calcium in the blood is over 11 mg. per 100 c.c. and the phosphorus in the plasma below 3·5 mg. per 100 c.c.

When such symptoms are present the neck should be explored for an adenoma or simple hypertrophy of the parathyroid glands. It is unusual for adenomata to be palpable from the surface because they lie so deeply and are of quite small size. Owing to the variable position of the parathyroid glands a search for the offending adenoma

bronchitis, to which these children are liable, is treated on medical lines.

Infantile Scurvy

This is a very rare disease now owing to general improvement in the standard of living of the poorer classes. It occurs from 6 to 10 months of age. The child suffers from pallor and wasting and is fretful. It usually has swollen gums. It is noticed to show great hesitation in moving its limbs and swellings may occur on the bones. These swellings are subperiosteal haemorrhages. Bleeding may also occur into the subcutaneous tissue, or from the bowel or kidneys. Any teeth which have erupted are apt to become loose and fall out.

The disease lasts for three or four months and is due to lack of vitamin C in the diet. The condition is of interest because the swellings of the bones are likely to be mistaken for new growths, but it is easily cured by remedying the deficiency in the diet. The children should have orange or lemon juice, milk, green vegetables and meat.

Osteomalacia

This is another disease in which the bones become very much softened. It is very rare in this country, but it is more common amongst some of the ill-nourished people of Central and Eastern Europe, and was seen in such countries after the Great War. There is deficient calcium and phosphorus absorption with, in consequence, a decalcification of the bones; in fact the disease corresponds almost exactly in pathology with the rickets of childhood. It is very much worse in pregnancy and during lactation because of the need of the foetus or infant for calcium. The patients have a steatorrhoea and there is great lassitude and weakness, with pains in the limbs and back on movement or on pressure on the bones. There is often some fever present. The bones bend very often to an extreme degree so that there occur curves in the limb bones and in the spine, whilst the pelvis becomes triradiate from pressure of the femoral heads and the sacrum, as in rickets. This may cause great obstruction during parturition.

The treatment of osteomalacia is the same as the treatment for rickets. The old remedy of removal of the ovaries has long been discarded with the elucidation of the pathology of the disease.

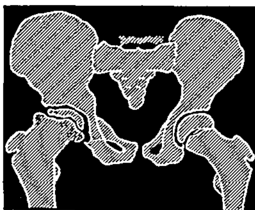
Renal Rickets

Renal rickets very much resembles ordinary rickets. It is due to an acidosis produced by disease of the kidneys so that calcium is lost.

extremely rarefied and fragile. They are small and slender and break with a minimum of force. The children have remarkably blue sclerotics and are frequently deaf. The blood chemistry is normal. The pathology of this curious condition is completely unknown. The healing of the fractures, which may be very numerous, takes place, but is slow. There is no treatment known for the disease. The fragility may gradually disappear as the child grows up.

Osteochondrosis of the Growth Centres

Pseudocoxalgia (Osteochondritis Coxae Juvenilis; Perthes' Disease).—This disease of the epiphysis of the upper end of the femur occurs in children at about the age of 7 years. The child is noticed to limp on one leg and he may complain of some pain referred to the hip joint. Occasionally there are acute symptoms of arthritis in the joint accompanied by spasm of the muscles and rigidity. Usually, beyond the limp, there will be nothing but a slight wasting of the glutaeal and thigh muscles, a position of adduction and some limitation of abduction and internal rotation. The condition has often been mistaken for tuberculous disease of the hip joint, but it is easy to distinguish because of the adduction of the hip at a stage when the patient is able to walk about in comparative comfort.



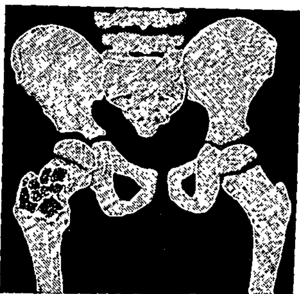
Skiagram of Perthes' disease. Note the flattened head and acetabulum and the wide neck of the femur with areas of rarefaction.

The X-ray examination shows at first an increase in the density of the bony nucleus in the head of the femur. A little later this nucleus becomes fragmented and then the cartilage surrounding it, owing to the pressure of the acetabulum, becomes mushroomed out. In the neck of the bone, close to the epiphyseal cartilage, there are areas of rarefaction and there is deposition of bone along the upper surface of the neck which becomes much thicker than normal. As time goes on the acetabulum becomes adapted to the deformed head and in the X-ray it looks flatter and shallow. Some observers have described changes in the bones surrounding the acetabulum similar to those in the head of the femur. After many months the changes come to an end and re-formation of the nucleus in the head occurs, but the reconstituted

may be a long and baffling operation. The hypertrophied parathyroid has actually been found in the thorax. The removal of these abnormal glands leads to a rapid cure of the disease.

Osteitis Fibrosa Cystica Localisata

In this condition there is a solitary area in the bone in which the marrow has been changed into fibrous tissue and many of the bony lamellae destroyed. The disease occurs in young people under 15 years of age and it affects particularly the upper part of the shaft of the humerus or the upper part of the femur. Histologically, the condition is indistinguishable from generalised fibrocystic disease of bone, but there is no alteration in the activity of the parathyroid glands. The X-ray examination shows what appears to be a cavity in the bone traversed by intersecting trabeculae, very much like the appearance of an osteoclastoma but, whereas the latter tumour invades the epiphysis, the former is further from the extremity of the bone and never reaches beyond the epiphyseal cartilage. In the humerus the fibrous tissue usually degenerates so that a cyst is formed (simple bone cyst), but, in the femur, the disease often remains a fibrous osteomyelitis.



Skiagram of simple bone cyst of femur.

Usually there is little pain associated with the condition and very often the first sign, if no swelling is noticed, is a pathological fracture. Such pathological fractures unite and the disease is cured. If, however, the malady is diagnosed before fracture the proper treatment is to expose the diseased area, scrape out the bone and paint the interior of the cavity left with pure carbolic. A cure will result. Occasionally it is necessary to resort to bone-grafting should a large part of the shaft be destroyed.

Fragilitas Ossium (Osteogenesis Imperfecta)

This is a rare condition which dates from birth, or even from before birth, for intra-uterine fractures may occur. The bones are

similar change occurring at the head of the second metatarsal bone and is seen usually in girls.

Kienboch's Disease of the Semilunar Bone in Adults.—Whilst the X-ray appearance resembles osteochondrosis it has probably a different pathology. It causes pain and some swelling and tenderness in the semilunar bone.

It is best treated by a plaster of Paris splint which keeps the wrist in the dorsiflexed position.

Calvé's Disease is osteochondritis of a vertebral body. It occurs in children of 5 or 6 years of age. The clinical features are very like those of Pott's disease from which it can be distinguished by X-ray appearances. Only one vertebral body is affected and it becomes much flattened. The intervertebral surfaces are regular, and the neighbouring discs are healthy. The bone is more opaque than normal. As the disease clears up some regeneration of the body occurs but it never gets back to its original height. Pott's disease always affects more than one vertebra and the disc is always destroyed.

Osteopetrosa (Albers-Schönberg's Disease; Marble Bones)

In this disease there is an increased density of the bones so that the medullary cavity is obliterated. It occurs in childhood and infancy and the X-ray shows a vague stratification bordering on the epiphyseal cartilage, demonstrating the intermittent character of the condition. There is usually great thickening of the clinoid processes in the skull and narrowing of the sella turcica. Transverse fractures occur but they heal with the formation of a great deal of callus. There are vague skeletal pains and perhaps a hypochromatic anaemia because of the disappearance of the marrow. There is no known treatment.

Skeletal Lipoid Granulomatosis (Schüller-Christian Disease)

This is a rare disease of infants and young children. There is a hypercholesteraemia with the formation of granulation tissue containing a number of cells filled with lipoid material. The granulation tissue is firm in consistency and putty-like in appearance. The lipoid is found between the cells as well as within their bodies. The formation of this tissue takes place particularly on the external surface of the dura mater, lining the calvarium, and between the two layers of dura mater surrounding the sella turcica. On the vertex of the skull the tissue invades the bone, causing decalcification. As well as these areas where the bone is deficient there are other areas where there are formed lumps on the skull. Children affected are poorly developed

head will be greatly deformed in shape and there will be a pronounced broadening of the neck and a shortening, because the growth of the neck has been impeded. Years later, osteoarthritic changes always seem to occur in such joints.

The diagnosis is easily made from tuberculous disease of the hip except in those cases where there is, at the beginning, an arthritis which causes a rigidity of the joint in all its movements. It is not, however, always possible to distinguish between coxa vara and pseudocoxalgia without an X-ray examination.

There are two methods of treatment; one is to provide the patient with a walking caliper splint to take the weight of the body from the hip joint and the other is to treat him in the recumbent position with weight traction from 10 to 18 months. The end-results of bed treatment are very much superior to the ambulatory procedure. If the pressure on the head of the bone is removed during the period of disintegration of the epiphyseal nucleus the bone may retain its shape and the deformity of the acetabulum be avoided, with also the avoidance of osteoarthritis.

Schlatter's Disease.—This is a similar disease of the tubercle of the tibia. There is usually some slight injury which causes periostitis in the region of the tubercle of the tibia, where the ligamentum patellae is attached. Pain is felt in this situation and a swelling appears. The removal of strain is essential and this can be done by encasing the limb in plaster of Paris, or better, by the use of a Cramer splint which can be fitted accurately to the back of the limb. The condition will ultimately clear up without further treatment but the tuberosity will always remain prominent. In the early stages a short stay in bed may be necessary.

Köhler's Disease.—This is osteochondritis of the tarsal scaphoid bone. It occurs in boys, as a rule, from 4 to 10 years of age, who come up complaining of an ache in the foot and a swelling over the navicular bone where there is some tenderness.

The X-ray shows the same increase in density of the osseous nucleus, a flattening of it and fragmentation. Some splint is necessary and a plaster of Paris casing should be made in the early stages of treatment. An arch support and strapping is sufficient later on.

Apophysitis of the Os Calcis is the same pathological process occurring in the epiphysis at the posterior extremity of the calcaneus. It is seen in boys and causes a tender swelling in this region and is accompanied by pain on walking. Fixation in plaster is the best treatment.

Köhler's Disease of the Second Metatarsal.—This appears to be a

of the legs calcification of the arteries is frequently seen, as atheroma is a very constant feature of the disease. Sometimes pathological fractures occur from very slight injuries. They are nearly always transverse and they heal quite well. Sarcomata may develop in one of these bones.

The disease has a very chronic course, lasting many years, and does not directly lead to the death of a patient unless malignant disease supervenes. The interference with respiration from the falling in of the chest predisposes to pulmonary complaints. No known treatment arrests the course of the disease and the pathology is quite obscure. It has been thought that there must be some relation between Paget's disease and generalised osteitis fibrosa but no such connection has been demonstrated. It is curious that the thickening of the skull bones seldom, if ever, gives rise to headaches. Very occasionally pain in one of the bones, such as the tibia, is so great that it can only be relieved by saw-cuts in the bone, guttering or making multiple drill-holes.

with obviously some upset of nutrition. They are likely to be irritable and peevish, which may be associated with the thickening of the dura mater. The formation of the granulomatous masses at the base of the skull gives rise to pressure on the hypothalamus and so to diabetes insipidus, polyuria and polydipsia. The growth of the granulation tissue spreads through the sphenoidal fissure into the orbit where it also causes exophthalmos.

It is probable that the lesions tend to become stationary and disappear. In the treatment little can be done but to prescribe a diet as free as possible from cholesterol. Pituitary extract may control the diabetes. Deep radiotherapy seems to give good results.

Osteitis Deformans (Paget's Disease of Bone)

This also is rather a rare disease. It occurs in middle life and is very chronic in nature. As a rule, a number of bones are affected but sometimes only a single bone is invaded. The disease consists essentially in a chronic inflammation of the bone and appears to originate in the marrow and spread through to the periosteum. In the process a decalcification with absorption of osteoid tissue takes place and the original bone is replaced by a fine network of new spongy bone as this rarefaction and softening occur. At first the bones become soft and deformed from mechanical stresses. The ultimate result is a much thickened bone, at one stage rather light and porous in nature, but in the end dense and sclerosed.

The disease usually begins imperceptibly and may be present for a long period before the patient is aware of it, but, in other cases, there are pains in the bones. The flat bones of the skull very frequently take part in the disease so that the head becomes larger from the thickening of the vertex, and altered in shape so that the forehead seems to overhang the face. It is common for a patient to say that he has had to buy a larger size of hat. The spinal column shows the disease by a progressive kyphosis, and the ribs being softened, the chest falls in. The long bones, and particularly the tibiae, become much thickened and curved forwards whilst the femora become convex outwards. The forearm bones are likewise bent, but the humerus often escapes. The end-result of all these deformities is an individual of very characteristic appearance. He has a large head, bent back, curved limbs and, because of his stooping attitude, arms which hang near the ground like those of a gorilla.

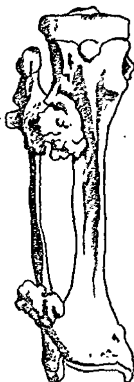
If an X-ray photograph be taken of the bones they present a curious woolly appearance due to some areas being rarefied and others sclerosed, whilst the surface lines become indistinct. In such X-rays

fracture of a phalanx occurring, or the tendons being interfered with. They should also be removed because occasionally they take on a malignant growth, becoming chondrosarcomata. Enchondromata also grow from the irregular bones, such as the scapula, or the long bones, in which they may attain a very large size.

Osteomata

Osteomata.—These tumours are of two varieties: (i) those that are formed by the ossification of cartilage, cartilaginous exostoses or spongy exostoses. (ii) Those which grow from the membrane bones and are formed by the direct ossification of fibrous tissue. These are called membranous exostoses, or ivory exostoses.

(i) *Cartilaginous Osteomata* grow from the ends of the long bones in the neighbourhood of the epiphyseal cartilage. They are very often multiple and there is an hereditary tendency to their formation. They grow from the epiphyseal line in childhood, and as they increase in size they tend to become mushroom-shaped or, more often, they are turned backwards along the shaft in the form of a hook. They are covered by a layer of cartilage which continues to grow and be ossified until the epiphyses unite. Cartilaginous exostoses are seen around the knee-joint occurring from the lower end of the femur more than in any other situation, but they can grow on any long bone.



Cartilaginous exostoses: diaphyseal aclasia.

Some pathologists believe that they are derived from portions of the epiphyseal cartilage which have become separated and have taken on an independent existence. Another explanation has been given. It has been already mentioned that the periosteum moulds the shaft of the bone as new additions are made to it from the epiphyseal cartilage (see page 480). If this process is disturbed and the proper re-shaping of bone does not occur, it can easily be understood that irregular projections in this situation will arise, and the hook especially can be explained because of the upper surface of the periosteum curling back to prevent ossification in that region. Such a disturbance might be due to some alteration in the activity of the ductless glands. This would explain the multiplicity of such lesions and the hereditary

CHAPTER XL

TUMOURS OF BONE

(a) Innocent:
  (i) Fibroma.
  (ii) Chondroma.
  (iii) Osteoma.
  (iv) Osteoclastoma.
  (v) Lipoma.
(b) Malignant:
  (i) Multiple Myelomatosis.
  (ii) Osteogenic Sarcoma.
  (iii) Fibrosarcoma.
  (iv) Endothelioma.
  (v) Metastatic Carcinoma.

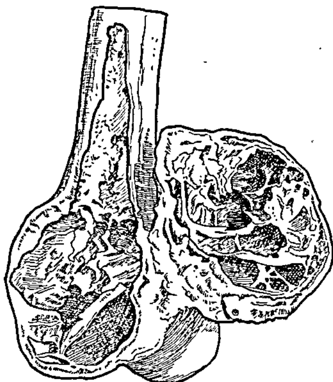
Fibromata

Fibromata of Bone are rare tumours which are small in size and grow from the periosteum, for instance from one of the phalanges or the lower jaw, where the growth is called a fibrous epulis (see page 236).

Chondroma

Chondromata of Bone grow from the interior of the cancellous tissue and are therefore called enchondromata. True enchondromata are rather rare tumours. They are seen more particularly in the phalanges or metacarpals of the hand, where they are apt to be multiple. They grow in the interior of the bone and cause what is called expansion of the bone. That is, as the interior of the bone is eaten away the periosteum on the surface deposits new bone, so that, for a long time, the tumour is encased in a bony shell. Ultimately, however, it will grow through this shell and come to lie under the skin. Enchondromata of the fingers should be removed at an early stage as, if they have grown to any size, they cannot be removed without a

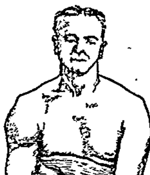
may pulsate. It may also degenerate and leave nothing but a cyst in the bone, containing blood. By X-ray the expansion of the bone is



Osteoclastoma of lower end of femur.



Skiagram of osteoclastoma of lower end of radius.



Subperiosteal lipoma of humerus bulging the deltoid.

evident and there is often the deceptive appearance of a number of septa dividing the cavity into loculi. These partitions are really the areas of bone left between excavations in the wall. The tumour grows right through the epiphyseal cartilage up to the articular

tendency. Because of this view of the origin of spongy osteomata, the name diaphyseal aclasia has been given to the condition.

Cartilaginous osteomata cease to grow when adult life is reached, and the whole cartilage ossifies. They may need removal because of interfering with the movements of tendons, for instance the gracilis and semimembranosus in the region of the knee joint, or because their presence interferes with some activity of the patient such as riding. When they are removed before adult life, care should be taken that the bone, at its base, is gouged out to form a small hollow or they will recur.

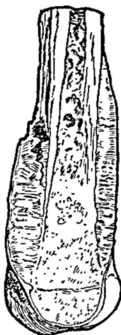
(ii) *Ivory Osteomata* are composed of very dense bone. They grow from the bones of the vault of the skull, from the interior of the orbit, the external auditory meatus or the nasal cavities. When they grow on the skull they produce no symptoms unless they project inwards and cause pressure on the brain, when it may be necessary to remove them. In the external auditory meatus they cause deafness and predispose to infection from obstruction. In the orbit they may cause diplopia by interfering with the movements of the eye. In the nasal cavity they cause nasal obstruction with results which may follow from this such as infection of the accessory sinuses.

The great difficulty about removing ivory osteomata is their extreme hardness. An attempt to chisel them off is more likely to result in the bone from which they are growing being fractured than in the separation of the tumour, so that it is very dangerous to attempt to chisel off an exostosis of the external auditory meatus, for facial paralysis or complete deafness may follow. They can, however, be removed with safety by the use of an electric or hand burr, or drill.

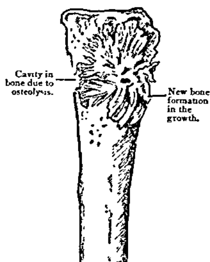
Osteoclastoma

Osteoclastomata are benign, giant-celled tumours of bone which have their origin always in the interior of the cancellous bone. They are commonest between 20 and 30 years of age. They are found more often in the lower end of the femur than anywhere else. An osteoclastoma gradually eats into the bone, which it replaces and causes that expansion of the bone which has been referred to under the enchondromata. The bone may become very large in circumference where the osteoclastoma is situated. Clinically there is nothing but a swelling. The skin over the tumour may show dilated veins, and if the encasing bony shell is very thin there may be a curious feeling of indentation on pressure such as is got by squeezing a ping-pong ball (egg-shell cracking). Ultimately, the tumour will grow through the bone and form a mass under the skin. The tumour is extremely vascular and

surface of the bone it soon breaks through the overlying cortical tissue and forms a well-defined lump on the side of the bone with a distinct edge. These tumours are composed of spindle cells or irregular-shaped cells many of which have the property of producing bone. This new-formed bone takes the form of plates which radiate from the centre of the tumour outwards from the surface of the bone like the cooling fans of the radiator of a motor-car. They give a very characteristic appearance in the X-ray photograph. On other occasions the bone formation is irregular and gives a simple stippled appearance, but always the normal outline of the bone has been interfered with, showing destruction. Formerly those tumours which grew from the periphery in this way were called periosteal sarcomata, while those which began deep in the substance of the bone were called endosteal



Osteogenic sarcoma of lower end of femur. Note the radiating spicules of bone tissue and how the growth has invaded the medullary cavity as well as surrounded the shaft.



Osteogenic sarcoma of tibia.

sarcomata, but really there is no distinction between the two groups of tumours.

A Periosteal Sarcoma may begin with pain but, sometimes, the first sign is that of a lump on the surface of the bone. This lump is more likely to be situated towards the end of the shafts of one of the long bones, but sarcomata may grow from any bone in the body. On palpation there is usually an abrupt edge to the tumour, that is, it does not shelve off into the surrounding bone as inflammatory lesions do. Seen through the skin covering it are dilated veins, and the sarcoma may feel warmer than the rest of the limb because it contains so much blood. Sarcomata sometimes actually pulsate from the same reason. Firm pressure may give rise

cartilage. This distinguishes it from a simple bone cyst, which never invades the epiphysis.

In the treatment of the condition there is no need to amputate unless a single bone has been so destroyed that there is no chance of regeneration proceeding to such a degree that the limb will become useful again. In the lower end of the femur, for instance, removal of the tumour might leave so little bone that all prospect of its ever being strong enough to support the weight of the body would be lost. Under these circumstances amputation is the obvious treatment, but in the case of the tibia where there is another supporting bone and the bones of the upper limb, the tumour should be removed from the interior of the bone, the cavity curetted and painted with pure carbolic acid, after which it should be closed by one of the methods for dealing with bone cavities (see page 485). The filling of it with bone chips has been very successful. These tumours never give rise to metastases.

Lipoma

A lipoma sometimes grows from the deeper layer of the periosteum, forming a soft fluctuating swelling.

Multiple Myelomatosis (Giant-celled Sarcoma)

It is a disease of middle-aged people and the myelomata grow within the cancellous tissue of the sternum, the ribs or the vertebrae chiefly, though sometimes they grow in the other bones. There is a secondary anaemia associated with the disease. The patients complain of pains in the bones, especially the back, and may suffer from pathological fractures, particularly of the ribs. The first symptom may be the discovery of the tumour on one of the bones. In a large proportion of these patients there are chronic nephritis and Bence-Jones protein (proteose) in the urine. There is no treatment and the disease is usually fatal from exhaustion or the results of nephritis.

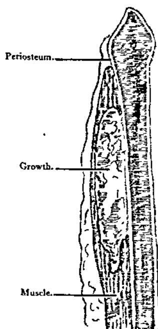
Osteogenic Sarcoma

Osteogenic Sarcomata of Bone are rather rare tumours which grow from marrow tissue. There is frequently a story of an injury. As a rule they begin in the tissue occupying the cancellous spaces of the metaphysis of bone. In the course of their growth the bone is destroyed and the tumour reaches the surface and invades the soft parts, or it arrives at the medullary cavity when it spreads rapidly through the marrow in this space. If the tumour begins near the

in its effects. At one time it was held that osteogenic sarcomata were *particularly unfavourable for therapeutic radiation, but this is not* universally true. There are cases where radiotherapy produces regression and considerably prolongs the life of the patient. There are no instances of cure. It is not possible to foretell which tumours will prove to be radio-sensitive and which radio-resistant. Therefore, when it is not possible to remove an osteogenic sarcoma, radiotherapy should be given a trial.

Fibrosarcoma of Bone

This is a sarcoma which grows from the outer layers of the periosteum. It is called a parosteal sarcoma. Such tumours form lumps attached to a bone but they show no *tendency to invade the osseous tissue.* An X-ray reveals the surface of the bone as being intact. These tumours do not show the same tendency to dissemination as osteogenic sarcomata. Amputation will often effect a permanent cure.



Parosteal sarcoma of fibula.

Endothelioma

Endotheliomata of Bone (Ewing's Tumour).—These tumours occur in young people and affect, as a rule, the shaft of one of the long bones. They almost invariably come after some injury. They are rare in their incidence. There is a febrile disturbance accompanied by severe pain which may last for some weeks and then subside. The condition simulates osteomyelitis. After an interval a like attack will occur, and in this way the disease will proceed. In the end the disease disseminates to many bones in the skeleton. Ewing's tumours occur not only in the long bones but in such bones as the pelvis. There is no known cure but the tumours are very radio-sensitive and relief can be given and life prolonged for a very considerable period by the use of X-rays.

Carcinoma

Secondary Carcinoma of Bone is the commonest form of malignant disease of bone but it occurs only with any degree of frequency when

to a sensation of the crunching of small fragments of bone, which is actually the case. Most sarcomata are very rapid in growth so that, in a few weeks, a distinct increase in size can be detected.

The Central Sarcomata may be very much more extensive than would appear to be the case from external examination because of the spread along the marrow cavity in the interior. Osteogenic sarcomata of the long bones are some of the most malignant tumours known. Dissemination occurs early by the blood-stream and almost invariably growths appear in the lungs. When they are of small size they may be detected by the X-rays. When they become larger they give rise to dyspnoea on exertion, cough and haemoptysis. This great tendency to dissemination must be taken into account when the question of treatment arises. There are very few recorded instances of permanent cure after amputation for an osteogenic sarcoma of one of the bones of the lower limb. There are more instances of recovery when the operation has been done for disease of the upper limb. However, it is very often right to perform an amputation because, if the patient loses the limb, he will be freed from a great deal of pain and suffering. The tumour ultimately grows to a large size, ulcerates on the surface and becomes septic. During this process large nerves may be invaded by the growth or become inflamed by the septic process, causing excruciating pain. The septic absorption will itself cause great distress. Therefore it is wise to advise an amputation of the limb above the growth. Owing to the tendency to grow along the marrow cavity, it was at one time recommended that the whole of the affected bone should be removed. As there is not usually a possibility of permanent cure, such a large operation is unnecessary. The limb should be amputated at some place above the growth away from any septic areas, so that primary union may be obtained.

Coley's Treatment.—For many years Coley, in America, advocated the treatment of sarcomata of bone by injection with a vaccine made of the combined toxins of *Streptococcus erysipelatis* and *Bacillus prodigiosus.* The injection of this fluid brings about an acute inflammatory reaction whereby the patient is made extremely ill, the temperature rising to 104° perhaps. The tumour swells up temporarily and then gradually disappears. Most interesting records of this treatment have been published by Coley in America. It seems undoubtedly true that he did get such results but in this country it has not been possible to emulate the successes. Neither could Coley himself get good results from material put at his disposal here. So that the treatment with Coley's fluid has been discarded by English surgeons as causing unnecessary distress without any compensatory relief.

The radiation of sarcomata by X-rays or radium is very uncertain

colour; the blood seems to be pressed out of the abdominal veins into the vertebral plexus. In the spinal extradural space there is normally a slight negative pressure which may play its part in sucking the blood into the intraspinal veins. There are no valves in the vertebral system or veins of the meninges or skull bones. After injection into small veins of the breast the material was found in the clavicles, intercostal veins, head of humerus, cervical spine and sinuses of the skull.

Hydatid Disease of Bone

This disease is rare. The cysts are small and exogenous in character. They form in the cancellous tissue of the long bones. Owing to the scattered nature of the lesions the bone quickly becomes destroyed over a wide area. Pathological fracture is usually the first symptom. When this happens the disease spreads to the soft tissues around the bone. An inflammatory reaction occurs with the formation of a mass like a rapidly growing sarcoma. At this stage there is no possibility of curing the disease; the only course is amputation.

the original carcinoma is in the breast in women, or the prostate in men. Rarely a thyroid carcinoma, or a growth of the kidney, or, exceptionally, a carcinoma of the bladder will deposit cells in the bones. Secondary carcinomata are particularly frequent in those parts of the skeleton where there is red marrow; hence metastases are seen in the vertebral column, pelvis, skull bones, ribs and upper halves of the long bones. They are usually accompanied by considerable pain and there is frequently an absence of swelling of the bone, the substance of which is eroded until a pathological fracture occurs. Sometimes a sudden collapse of the vertebral column will result from this process and cause a paraplegia. In the X-ray the shadow of the bone will be very defective and there is no trace of new bone formation. Whilst the part of the bone affected with malignant disease will not unite, the healthy part of the bone, which has been fractured, will do so, and it does not mean because a fracture of the femur has united that it was not due to secondary carcinoma occurring locally. Curiously enough, the primary tumour in the breast may be so small that it is overlooked by the patient and may be hard to discover by a surgeon. Bone metastases in secondary carcinoma of the breast or prostate are nearly always multiple but, in the case of the kidney or the thyroid gland, a single metastasis may occur. It is sometimes possible to remove the primary growth and a single metastasis with very great prolongation of life. Secondary carcinomata of bones due to the prostate or breast should receive no local treatment beyond the splinting of the limb or spine to afford relief from the pain and perhaps the application of X-rays which sometimes surprisingly causes them to regress.

A rare metastasising tumour of the thyroid is the malignant colloid goitre. Metastases may have the same structure as the original tumour and, remarkably enough, secrete thyroxin which can be utilised by the body. This is the only known example of a malignant tumour having an activity which is of use to the organism as a whole.

The mechanism by which carcinoma cells reach the bones has been explained by the experiments of Batson, who, in cadavers, injected the dorsal vein of the penis with vermilion water colour. The dye passed into the prostatic plexus of veins and thence along the pelvic veins into the vena cava. By X-raying it could be detected in the ilium, sacrum and sacral canal. With a very fluid injection the material went up along the vertebral plexus of veins to the base of the skull and the cranial cavity without any appearing in the vena cava. Similar results were obtained in living monkeys. Pressure upon the abdomen or coughing favoured this unusual passage of the

plexus which was named by William Hunter the *circulus arteriosus articuli*. Hence, when the synovial membrane becomes inflamed the outpouring of fluid may be very profuse and take place very rapidly. On the other hand, the articular cartilage itself has no blood-vessels in it, and this has some bearing on the results of infection. It is found, for instance, that the part of the cartilage which first becomes destroyed is the superficial part where it is subjected to pressure so that the periphery of the cartilage, well supplied by the circulus arteriosus, and the deep layers of the cartilage, also well supplied with nutriment from the network of arterioles in the underlying bone, escape damage for much longer. It has been proved that staphylococci and streptococci produce a ferment which dissolves away articular cartilage, whereas the tubercle bacillus secretes no such ferment. The importance of this clinically is that in all inflammations of joints of any severity some measures should be taken to relieve the pressure between the two articular surfaces. This is usually done by attaching a weight to the distal part of the limb in order to tire the muscles which keep the two bones in apposition. Another important anatomical fact is the abundance of nerves which are found in the synovial membrane and in the bone just beneath the articular cartilage. This not only makes joint affections particularly painful but, because of this abundant nerve supply, there seems to be a very important reflex effect upon the nutrition of the muscles which move the joint. When a joint is immobilised in plaster of Paris the muscles which move it waste and they do not recover their tone until the joint has been used again for some considerable time; but the wasting which comes on through disuse is mild in degree compared with the wasting which results from disease. One of the most prominent clinical features of chronic joint disease is this atrophy of muscles which is to be observed more in those above the joint than in those below, *i.e.* the upper arm muscles are particularly wasted in disease of the elbow joint, the thigh muscles in disease of the knee joint, and the glutaeal muscles in disease of the hip joint. This wasting resulting from disease has been proved to depend upon nervous impulses by observing its diminished intensity in an inflamed joint when previously the nerves coming from or going to the joint have been divided. Associated with inflammation of the joint there is also an increase of the tone of the muscles. They go into spasm although they are wasted.

In the older textbooks synovitis and arthritis are described as two separate entities, the one being alleged to be simply inflammation of the synovial membrane and the other an inflammation of all components of the joint. It is very doubtful whether the synovial membrane becomes inflamed without there being changes in the cartilage, but

CHAPTER XLI

DISEASES OF JOINTS

ARTHRITIS

STRICTLY the term arthritis should connote inflammation of a joint, but it is used to embrace such affections of joints as are only partly inflammatory in nature, such as those which occur in diseases of the nervous system.

Arthritis can be classified according to its cause as follows:

1. Traumatic.
2. Infective:
   - (a) Pyogenic:
     - Staphylococcal.
     - Streptococcal.
   - (b) Pneumococcal.
   - (c) Gonococcal.
   - (d) Typhoid.
   - (e) Influenzal.
   - (f) Dysenteric.
   - (g) Tuberculous.
   - (h) Syphilitic.
3. Toxic:
   - (a) Arthritis Deformans:
     - (i) Rheumatoid Arthritis.
     - (ii) Osteoarthritis.
   - (b) Haemophilia.
   - (c) Gout.
4. Neuropathic.
5. Hysterical or Mimetic Joints.

The changes which take place when a joint becomes inflamed vary very much but there are certain general phenomena. There is a very abundant blood-supply to the synovial membrane and particularly are the blood-vessels collected in the region of the joint where the synovial membrane, cartilage and capsule meet one another and form a vascular

ments are torn and muscle fibres ruptured. Sometimes the attachment of a ligament tears off a little flake of bone with it. This is called a sprain-fracture.

At first there is a sickening pain in the joint which is soon followed by swelling and discoloration around. The neighbouring tendon sheaths are filled with fluid. There is great tenderness at the point where the ligament is ruptured. There may be prolonged limitation of movement owing to the formation of adhesions in the joint and in the tendon sheaths. In old persons osteoarthritis may result and in young people it is sometimes a precursor of tuberculosis.

The treatment of contusions and sprains is similar. Firm pressure over wool will limit the quantity of liquid poured out into the joint and tissues. When such effusion has ceased to take place, that is, in about 24 hours, light movements and massage help to cause absorption. As an alternative, the joint may be strapped. In the case of the ankle joint, active use is good, but, in the case of the knee joint, walking should not be allowed unless the knee is supported in a splint. The most convenient is a posterior Cramer wire splint from the upper third of the thigh to the lower third of the leg together with a narrower Cramer splint on the inner side of the joint where it protects the internal lateral ligament from further damage.

When the knee joint is very tense with effusions great relief is given by aspirating the fluid from the joint.

Open Wounds of joints are serious lesions for they may be followed by sepsis in the joint. When seen early, the edges of the wound must be excised after washing the surrounding skin with soap and water. If the wound has been made with a comparatively clean instrument, the synovial membrane is sewn up and a drain left in the wound leading down to it. The wound may be sprinkled with penicillin-sulphathiazol powder. If the joint is likely to have been infected it may be washed out with saline solution before doing this. 100,000 units of penicillin are injected into the joint cavity from the uninjured aspect if possible. In every case the joint should be immobilised in a splint. The treatment of suppurating joints is described under pyogenic infections.

Internal Derangements of the Knee Joint

Injuries to the Semilunar Cartilages of the Knee Joint

These are caused by violent injury to the joint and so are common in football players, other athletes and coal miners. The internal semilunar cartilage is more often affected than the external. The

the distinction is very useful clinically. When the synovial membrane alone is inflamed and the degree of damage to the cartilage is not great, then the clinical phenomena are of a much milder character. The pain is not so great in the joint, and movement, whilst it is always restricted in range, is not abolished. But as the inflammatory condition within the joint progresses, and presumably when the articular cartilage has been so damaged at the points of pressure that the inflammation is likely to have reached the nerves in its deeper part, then the clinical picture changes. The pain becomes much more intense, the joint becomes absolutely fixed by muscular spasm, any attempt at moving it being intolerable. If it is a joint in the lower limb which is affected, the patient is completely unable to put any weight on it, whereas during the stage of synovitis he could do so. Then, at night, there occurs the phenomenon known as night startings. In this the patient is suddenly wakened from sleep with a sudden jerk in the joint accompanied by excruciating pain which makes him yell out. Apparently the spasmodically contracted muscles relax a little during sleep, a slight involuntary movement of the joint is allowed and this reflexly causes a sudden tightening up of the muscles which is the cause of the pain. So that, clinically, it is quite easy to differentiate between synovitis and arthritis. The two conditions require very different treatment.

The alteration in the form of a joint as a result of inflammation depends upon the changes in the synovial membrane. If this membrane is not much thickened but pours out abundant synovial fluid there is a swelling of the joint which takes on the actual shape of the anatomically distended synovial cavity, but in other conditions, particularly when the cause of the disease is the tubercle bacillus, there is little or no effusion but the synovial membrane and the surrounding tissues are changed into granulation tissue. This tissue is irregular in its formation so that the joint loses its characteristic shape and conforms to no regular pattern.

Injuries to Joints

A Contusion is due to the mechanical jarring of the two articular surfaces of the joint together. Swelling occurs through the pouring out of fluid both into the joint cavity and into the synovial membrane. The fluid is always blood-stained and there is discoloration under the skin. The limb is held in a flexed position. The fluid may persist for some time.

A Sprain is the result of the joint being moved beyond its physiological limits, or into a position it will not normally assume. Liga-

ments are torn and muscle fibres ruptured. Sometimes the attachment of a ligament tears off a little flake of bone with it. This is called a sprain-fracture.

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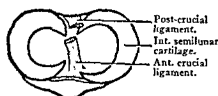
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injury occurs when the foot is firmly planted on the ground and with some abduction of the knee joint. There is a forcible internal rotation of the femur upon its upper surface. This seems to bring the thin edge of the cartilage nearer the centre of the joint, and with the elastic recoil that follows this thin edge is fixed between the articular surfaces while the periphery of the cartilage is dragged towards the surface of the joint, because it is attached to the internal lateral ligament. The result is a powerful cross strain which causes a longitudinal split in the cartilage. The central part of the cartilage remains between the bone ends and affords an obstacle to complete extension of the knee joint. The term "bucket-handle" deformity is given to a simple longitudinal split. Combined with this longitudinal fissure, however, there may be a transverse rupture of the partially separated portion. The transverse fracture may be either at the anterior or the posterior extremity. Fracture of the external cartilage is brought about by the opposite movement, that is, rotation outwards of the femur upon the upper surface of the tibia.



The arrangement of the structures on the upper surface of the tibia.


Injuries to the internal semilunar cartilage. On the left a "bucket-handle" tear: next a longitudinal combined with a transverse tear which becomes the third example. The last is a tear of the posterior part of the cartilage.

When the internal cartilage is fractured the clinical features of the condition are fairly distinctive. At the time of the accident the patient feels severe pain; sometimes he hears a click and he falls to the ground. He finds that he is no longer able to get his knee straight, though he can bend it quite freely. To this disability the term "locking" is incorrectly given. Very soon fluid is poured out into the joint cavity and it will be found that a point of tenderness, just to the inner side of the ligamentum patellae, can be demonstrated. There may also be some swelling at this point. The tender spot and effusion are due to tearing of the anterior attachment of the internal semilunar cartilage. At the same time there may be some injury done to the internal lateral ligament of the knee joint so that there is an additional tender spot, where fibres of this ligament are ruptured. The locking disability can usually be remedied by manipulation. It is frequently stated that by doing this the cartilage is reduced. If this means that the two fractured pieces of cartilage are brought into apposition it is not always correct, because sometimes movement is restored by the

separated piece of cartilage being driven further into the joint.

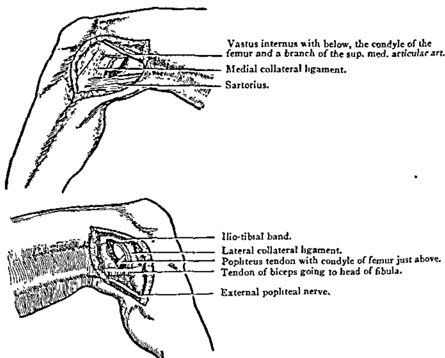
Reduction is brought about by strongly flexing the knee joint, externally rotating it and then extending it rather suddenly. This is the usually described method of reduction but has the disadvantage, should the first attempt fail and should the patient not be under an anaesthetic, of being extremely painful. Even should he be under an anaesthetic more damage may be done to the cartilage itself. The preferable method is to flex the knee joint strongly and then to shake the joint forcibly from side to side by hitting the internal condyle of the femur with one hand and the external tuberosity of the tibia with the other hand alternately. This almost invariably shakes the separated cartilage from its position between the articular surfaces, and it will be found that gentle extension of the joint will prove that reduction has taken place.

The future treatment is important. A Cramer splint should be fitted to the back of the limb and one on the inner side, and the patient should be allowed to walk in this. The splint should be kept on for at least a fortnight in order to allow torn ligaments to repair. There is a certain amount of controversy as to whether a fractured cartilage ever heals. It is certainly true to say that after one attack of derangement and reduction the patient may never suffer again from a similar injury. Presumably, in such cases, the two torn surfaces of the cartilage are brought into apposition and joined up by fibrous tissue. On the other hand there are many cases in which a recurrence of the disability occurs. In these it is supposed that the separated piece of cartilage has been reduced into the centre of the joint. As subsequent attacks occur reaction in the joint itself becomes less. On the first few occasions a great deal of fluid is poured out but, on subsequent occasions, it becomes less and less in amount. Patients frequently seek advice with a history of repeated lockings. Under these circumstances the diagnosis is to be made largely upon the history of the original accident, but some help can be got by flexing the knee joint, acutely rotating the tibia strongly outwards and slowly extending the joint, during which procedure, at one definite point, a click is felt and perhaps heard. This is supposed to be the articular surfaces jumping over the torn cartilage which has been drawn between them by strong external rotation. It is a very significan sign when it can be elicited, and is characteristic rather of posterior than anterior tears.

Fracture of the external semilunar cartilage is much less common The signs and symptoms are similar but the pain is referred to the outer side of the joint. Sometimes there is a very definite jump felt in the joint when it is extended.

Fractures of the semilunar cartilages are usually met with in young adult life. Fractures of the external cartilage are sometimes seen in adolescents. After the primary accident, when reduction has been affected, an operation should not be advised because, as already mentioned, the patient may never suffer from a similar accident again, but, at the second attack of locking, the surgeon may be sure that repair of the cartilage is now impossible and he should recommend operative treatment because a fractured cartilage is always a danger to the patient. The unexpectedness with which it causes the joint to give way and throw the patient to the ground is a danger which menaces him throughout life.

In the operation the joint is opened on the inner side of the patella in front and the condition of the cartilage inspected. If there



The paths of access for draining the back of the knee joint. The posterior ends of the semilunar cartilages are reached in the same way.

is a pedunculated piece of cartilage lying between the condyles, it is very often quite sufficient to remove this portion alone. Very many patients have been cured by this simple operation, but if the cartilage only appears loose or if there is no visible injury to it, then it must be inspected from behind. This is done by a separate incision through the capsule, posterior to the internal lateral ligament. In such cases the whole cartilage should be removed. Some surgeons recommend that the complete operation should be the rule but it does not seem necessary to go to this extreme. The same principles apply to the surgical treatment of the external cartilage.

The patient can usually be up and use his limb by the tenth day. He should never have his internal lateral ligament divided, as is frequently done on the Continent, as a weak joint is likely to result, and, in any case, such an operation would necessitate prolonged immobilisation in plaster of Paris. From the severed peripheral attachment a new meniscus seems always to grow to replace that removed. It is composed of fibrous tissue, not of cartilage.

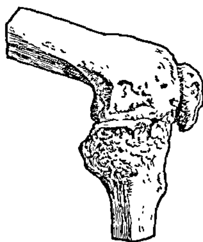
The internal derangement of the knee joint associated with a fracture of a semilunar cartilage is sometimes simulated by a loose body in the joint or an hypertrophied synovial fringe in osteoarthritis.

Loose bodies occur in otherwise normal joints; they consist of a *core of bone surrounded by cartilage.* They may have some relation to trauma and be separated portions of the articular surface. They may result from a curious process named osteochondritis dissecans. This condition occurs particularly in the knee joint, but is seen in the elbow and shoulder joints also. A portion of the articular surface appears to die as though there had been an infarct and is cast off into the joint. Loose pieces of cartilage in the joint can get sufficient nourishment from the synovial membrane to retain their vitality so that, in time, their shape changes and their relation to the articular surfaces becomes obscured. However this may be, loose bodies are likely to get caught between the articular surfaces and cause a locking which is very similar to that of a fractured cartilage except that there was no violent injury at the primary attack. Again, the patient will very often have noticed the presence of a movable hard body in the knee joint. These loose bodies are very elusive and escape from the examining fingers, so that they have been called "joint mice". Because of the possibility of their presence, a knee joint suspected of a fracture of a cartilage should always be X-rayed, for a skiagram will reveal a loose body. Loose bodies should be removed. They are not always in front of the joint. Careful estimate of their position should be made by X-ray examination and the corresponding compartment of the joint opened for their removal.

Sometimes in osteoarthritis a synovial fringe containing a nodule of cartilage will get caught between the bone ends and cause an attack which is very like the locking of a fractured cartilage. It is very easy to distinguish this variety of internal derangement because there will be distinct signs of osteoarthritis in the joint, namely the lipping of the trochlear surface of the femur and the presence of palpable fringes. Moreover, the patient will be beyond the usual age for fracture of a cartilage to occur. Only rarely is it right to operate for their removal, because surgical intervention is apt to make the general condition of the joint worse.

Pyogenic Arthritis

Under this term are included affections of joints with the staphylococcus or streptococcus. Infection may take place from without by an open wound or by extension from a neighbouring focus, particularly from osteomyelitis, but infection can also, under exceptional circumstances, extend inwards from the superficial tissues, *e.g.* the knee joint may become infected from an extension inwards of a cellulitis. In other cases the organisms are carried by the blood-stream as in puerperal sepsis and infective endocarditis or when there is some perhaps quite small local suppurating lesion in the skin. The infection of the joint is often ushered in by a rigor. There are high temperature and great pain. There is, at first, synovitis, such as has been described, which as it progresses becomes an arthritis. The serous fluid first poured out becomes fibrinous and ultimately purulent in nature. The joint cavity becomes distended and as the infection progresses the capsule and ligaments of the joint may become destroyed so that a pathological dislocation may occur. Pus will then break out of the joint into the surrounding tissues. When it has reached this stage the condition is very serious as it may lead to a general infection with perhaps death of the patient. If the cartilage covering the bone ends is destroyed, recovery can only take place by ankylosis.

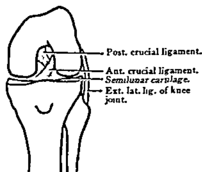


Bony ankylosis of the knee joint.

Treatment in all these cases is urgent. It is necessary to provide absolute rest for the joint and to diminish the pressure of the two articular surfaces against one another. Evacuation of the effusion is also required.

Knee Joint.—This joint is infected more often than any other and presents great difficulties in treatment because of the complexity of the synovial cavity. The front part of this space is imperfectly separated into right and left areas by the ligamentum mucosum whilst the subcrureal pouch forms a third compartment. The back of the joint communicates with the front only by the narrow passage between the anterior crucial ligament and the internal condyle. It is divided into right and left halves by the reflection of the synovial membrane over the posterior crucial ligament. So that we must regard the knee joint as an irregular cavity with five separate compartments not communicating very freely with one another. When there are signs of

synovitis of the knee joint and it is suspected that the cause is due to a pyogenic organism, the patient should be confined to bed and his lower limb should be immobilised in a Cramer splint or plaster of Paris. Aspiration of the joint should be carried out, the needle being inserted into the suprapatellar pouch. If the fluid is purely serous or only very slightly turbid, 100,000 units of penicillin are injected into the joint. If *numerous leucocytes have migrated* into the effusion and microbes can be demonstrated, the joint must be opened at the inner side of the patella and washed out with normal saline. The synovial membrane is sutured but the rest of the wound is left open. It is sprinkled with penicillin - sulphathiazol powder and lightly plugged with gauze. From the sound side of the joint 100,000 units of penicillin are injected. The joint is fixed in a plaster splint in 5° to 10° of flexion with traction by zinc oxide plaster of 6 lb. Systemic penicillin is given. Every 48 hours aspiration and injection of penicillin are carried out. Usually only two or three injections are necessary. If conditions are favourable (see page 14) the wound may be sutured secondarily in 5 to 10 days.



To show the arrangement of the crucial ligaments and the narrow communication between the anterior and posterior compartments of the knee joint.

In neglected cases one aperture for washing out the joint cavity will not be sufficient. For the ligamentum mucosum virtually divides the front of the joint into two whilst the reflection of the synovial membrane over the posterior crucial ligament does the same for the back of the joint. So an incision may be necessary in front on each side of the patella, one of which extends above this bone, opening into the subcrural pouch. The back of the joint is opened by incisions over the condyles: on the outer side between the ilio-tibial band and the tendon of the biceps muscle: on the inner side between the vastus medialis and the sartorius (see page 518). The joint can be then thoroughly flushed through. The synovial membrane is sutured and the joint treated as above.

Wounds of the knee joint which are due to accidental puncture frequently run a more benign course than those due to a blood-stream infection or to extension from the neighbouring bones. This is because the immunity of the patient is likely to be unimpaired. When a joint has been punctured in an accident the patient should be operated upon within a few hours.

As already mentioned, if the knee joint be infected secondarily

to osteomyelitis, it can usually be cured by repeated aspirations followed by the injection of penicillin.

Hip Joint.—The hip joint is particularly liable to be infected in association with osteomyelitis of the neck of the femur. It is also infected by the blood-stream in such conditions as puerperal sepsis. The characteristic position of the inflamed hip joint is one of flexion and adduction and if arthritis has become established there is extreme pain on attempting to move the joint. Curiously enough, a streptococcal infection of the hip joint is less serious than a similar infection of the knee joint, so much so that an operation can often be dispensed with.

Treatment.—Aspiration is carried out by directing the needle from 1 inch above the trochanter downwards and inwards to penetrate the joint cavity from above. Strapping traction should always be applied to the hip joint as soon as the condition is diagnosed. If operation should become necessary the joint is drained, as a rule by an incision, which exposes it in the front between the sartorius and tensor vaginae femoris. If ankylosis is feared the best position for the patient is to have his hip joint slightly flexed, slightly abducted and with the foot turned a very little outwards.

Shoulder Joint.—This joint is not often infected by pyogenic organisms. The swelling causes the deltoid to bulge and a tender point can be found below the coracoid process in front. Aspiration is best carried out by inserting a needle beneath the metacromion process from behind. The patient should be confined to bed and traction in abduction can be applied to the shoulder joint by strapping on the upper arm. The elbow should be kept at a right angle and the forearm supported in a vertical position, being attached to a pulley on an overhead beam, also by strapping. If an operation for flushing out the joint should be required, the incision is made running downwards from the coracoid process in front between the pectoralis major and the deltoid. The procedure then followed is similar to that described under Knee Joint.

Should ankylosis occur, the best position is to have the humerus at an angle of 45° with the trunk when the movement of the scapula will allow the greatest range of adduction and abduction possible.

Elbow Joint.—When this joint is infected it is a little difficult to apply traction to the separate articular surfaces so that, usually, the joint is simply immobilised in a plaster of Paris splint. The muscles of the upper limb are not nearly so powerful as those of the leg, so that there is not such great pressure between the articular surfaces and distraction with strapping is not so essential. Aspiration of the joint is carried out by entering the needle behind on the outer side

and going between the humerus and the head of the radius. Opening the joint, if called for, is best carried out in this same situation. Also, should ankylosis occur, the best position is one in which the forearm makes an angle of about 70° with the upper arm.

Other joints when affected are treated on the same general principles.

Pneumococcal Arthritis

In adults this occurs usually at the end of an attack of pneumonia, but in children it occurs apart from this as part of a general pneumococcal infection. The treatment of such joints is the same as has been already described but the urgency for operative drainage is not great. Repeated aspiration will often carry the patient through to recovery with a movable joint. Penicillin must be injected into the joint and given systemically.

Gonococcal Arthritis

Gonococcal arthritis only occurs in the male when the infection has spread to the posterior urethra and has lodged in the prostate and seminal vesicles, or in the female when it has lodged in some of the cervical glands or the Fallopian tubes. It occurs about 3 weeks after the initial infection and is more common in men. It is sometimes seen in babies with ophthalmia neonatorum. There are several varieties of gonococcal arthritis:

(1) A dry polyarthritis. This attacks numerous joints, particularly the small joints of the fingers and toes, the carpus and tarsus.

(2) A chronic serous synovitis which is monarticular and affects particularly the knee joint.

(3) An acute arthritis which may begin in several joints but settles finally into one, usually a large joint, such as the knee or elbow.

(4) A rare form of suppurative arthritis which ends in bony ankylosis.

The multiple arthritis which affects the feet and hands may be very crippling. In the foot it causes the arches to flatten and is extremely painful. In the hands the fingers may be distorted. The sternoclavicular joint is frequently affected also and so are sometimes the joints of the cervical spine. There is very little effusion into the joint cavities but a great deal of inflammation of the surrounding tissues.

The chronic serous synovitis is an almost painless effusion into the knee joint which may last for a considerable time and be very persistent, but eventually it disappears leaving a normal joint. The gonococci being intracellular are not found in fluid aspirated from the joint.

The acute arthritis comes on with very great pain and swelling. There is a serofibrinous exudation into the joint but the bulk of the increase in size is due to infiltration of the surrounding tissues. There is much periarthritis. The joint is hot to the touch and often red to the eye, so that it has a deceptive appearance of suppuration. The temperature is raised. The duration of the acute stage may be weeks. Great stiffness from contraction in the periarticular tissues is likely to remain.

In the treatment of gonococcal joints, in addition to measures already mentioned for arthritis, it is essential to eradicate the primary lesion; that is, the cervix uteri must be dealt with, the Fallopian tubes perhaps removed and the prostate and vesicles treated by massage. Some patients are extremely sensitive to this latter treatment so that it must be carried out very lightly and for a very short time in the first instance. The systemic administration of penicillin is called for. When the condition is chronic heat by diathermy is often of benefit.

Syphilitic Arthritis

In the secondary stage there is sometimes a transitory painful synovitis of the joints which soon disappears. In the tertiary stage the characteristic affection is a hydrops of the knee joint. There is a painless effusion into one knee joint first, and very often into the other knee joint a little later. It is also to be noted that the amount of fluid in the joint is apt to vary from day to day. These joints occur in hereditary disease as well as in the acquired variety. A bilateral effusion into the knee joints of children with congenital syphilis was described by Clutton. They are called Clutton's joints. Interstitial keratitis is frequently seen in the same patient.

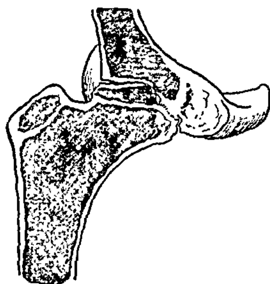
In the treatment it is necessary to aspirate the joint, support it with bandages or perhaps, if the effusion is much, a Cramer splint, and to give antisyphilitic treatment.

There is another variety of syphilitic arthritis which is seen both in congenital and acquired disease. In this the synovial membrane becomes converted into a thick irregular layer of granulation tissue. The resulting physical signs in the joint somewhat resemble tuberculosis but the swollen synovial membrane is apt to be more nodular in character and, sooner or later, the disease will spread to the surface and form the typical syphilitic ulcer with the steep sides, circinate edge and wash-leather slough on its base. There may be some syphilitic osteitis of the bones entering into the formation of the joint. The treatment here is fixation in plaster of Paris and the administration of antisyphilitic remedies.

Tuberculous Arthritis

When the tubercle bacillus attacks a joint we know that it must have arrived there through the blood-stream and that the invasion of the blood-stream is a secondary incident in the disease. The bacillus has entered the body through some lymph channel by way of the tonsil, the intestine or the lung, and has settled in a lymphatic gland. Owing to the spread of the tuberculous focus in the gland a blood-vessel has become invaded, hence the infection of the joint. A tuberculous arthritis must mean that resistance to the bacillus tuberculosis has broken down twice; once to permit the organism to get into the lymph gland, and secondly, to allow the organism to spread in the gland and gain entry into the blood-vessels. In the joint the bacillus lodges either in the synovial membrane or in one of the bone ends. It never settles in the cartilage so that we talk about a primary bony lesion or a primary synovial lesion of the joint. In the knee joint the incidence of the two methods of infection is about equal but in the hip joint there are more bony than synovial infections. When the bacillus lodges in the bones it settles in a region where the most recent bone formation has taken place, that is, in the metaphysis or at the periphery of the nucleus in the epiphysis. As a rule the cancellous spaces in the end of the bone become filled with granulation tissue and the disease process spreads laterally until it reaches the attachment of the capsule, when the synovial membrane itself becomes infected. In tuberculosis of joints there is very little effusion into the joint cavity as a rule, and then only in the early stages. Tuberculous hydrops of joints with small ovoid loose masses of fibrin (melon-seed bodies) is very rare. When there is much fluid in a joint the tubercle bacillus is a most unlikely cause of it. In the usual case the joint is deformed in shape because the synovial membrane becomes changed into a thick, soft, irregular mass of tuberculous granulation tissue which fills all the crevices of the joint. At first, in the knee joint for instance, the swelling can be seen on each side of the patella, and the subcrureal pouch is distinctly outlined, but, as the disease progresses, the inflammatory process affects the capsule of the joint and the periarticular tissues, so that the joint loses altogether its characteristic shape. This peculiar formlessness of tuberculous joints is quite characteristic and is seen in all the superficial joints such as the ankle, or elbow, or wrist. As the pathological process invades and destroys the capsule the bones are apt to separate so that a pathological dislocation occurs. Accompanying the swelling of the joint there is a concurrent wasting of the muscles which move the joint, particularly of the muscles of the limb above the level of

the joint, so that in the case of the shoulder joint the scapular muscles are wasted, in the elbow joint the upper arm muscles, in the knee joint the thigh muscles, and in the hip joint the glutaeal muscles. Like tuberculous granulation tissue in other places, points of caseation make their appearance and, coalescing together, soften to form cold abscesses. These cold abscesses reach the surface, break through the skin and leave tuberculous sinuses with thin blue undermined edges exuding a watery discharge often containing shreds of necrotic tissue. The outlook in a tuberculous joint is not very good. The majority of moderately infected joints are only cured with the joint's becoming ankylosed. Unless there is secondary infection it is a fibrous ankylosis. In a minority some movement is regained. In a few, generalised tuberculosis takes place or, from persistent secondarily infected sinuses, amyloid disease results.



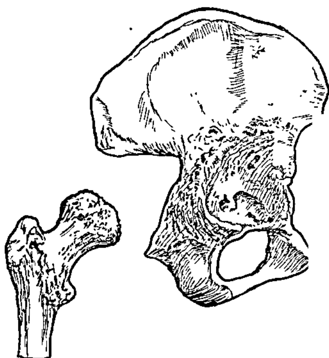
Fibrous ankylosis of hip after tuberculosis.

Tuberculous Disease of the Hip Joint

In the hip the disease nearly always begins in the bone, the common sites being the upper margin of the acetabulum or the lower part of the epiphysis of the head. It sometimes begins in the neck of the femur, close to the epiphyseal cartilage. A much rarer site of origin is the great trochanter, in which situation, although the tuberculous focus may spread up the neck to the joint, it sometimes fails to do so.

The first sign of this malady is usually limping. The patient, as a rule a child, is noticed to tire easily and to be less active. Pain is not a very prominent symptom to begin with. It may be referred to the knee and so lead to a diagnostic error. The reason for this is alleged to be the fact that the obturator nerve supplies both the hip and knee joints by its anterior and posterior divisions. If the joint be examined at this stage very little can be made out; there may be nothing but a slight limitation of some movement, particularly of rotation. A little later very characteristic signs and symptoms appear. The limp becomes more pronounced, there is wasting, especially of the glutaeal muscles, so that, on looking at the child from behind, the

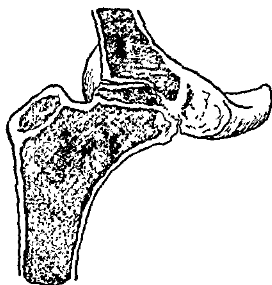
glutaeal fold is less distinct than on the normal side. It is also partly effaced by there being some permanent flexion of the joint which is demonstrated by flexing the good thigh strongly on to the abdomen, when the lumbar lordosis will be straightened out and the thigh on the diseased side will be raised from the bed. It will also be noticed that, in addition to this flexion, there is some abduction at the hip joint whilst the foot is rotated laterally. The abduction causes an apparent lengthening. Movements are restricted and it is important to note that all the movements of the hip joint are affected in this way,



Tuberculous hip. Note the encroachment of the acetabulum on the ilium in an upward direction, the destruction of bone and the numerous stalactitiform osteophytes.

i.e. flexion, extension abduction, adduction and rotation. If the region of the joint is palpated a thickening in front of the joint in Scarpa's triangle will often be perceptible. Sometimes it is actually visible. In this stage of the disease the patient can still walk about although he complains of pain after exertion. It is during this period that the disease is assumed to be confined to the synovial membrane. There is not yet much destruction of the articular surfaces. When this occurs the whole picture changes: the pain becomes intense so that the patient is no longer able to walk. He is obliged to take to his bed. The hip joint will now be found to be more flexed, adducted instead of abducted, and medially rotated instead of laterally rotated. There is apparent shortening of the leg because of the adduction. It is during this stage that night startings become

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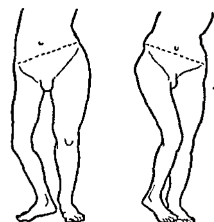
being that the deviation from the line is the same on the two sides, if the hip is normal. Nelaton's procedure is not a very accurate one *for estimating the height of the great trochanter* because the line is not a straight one but an arc of a circle, and the summit of this arc is not fixed. It is really a most unreliable method of clinical examination. Bryant's triangle is another way of obtaining the same information. The patient lies on his back and a vertical line is drawn upwards from the bed to pass through the anterior superior spine. On to this a perpendicular is dropped from the tip of the trochanter. The triangle can be completed by joining the anterior superior spine to the tip of the great trochanter. If the trochanter is in its normal



Tuberculous hip. The primary lesion is in a characteristic place, the lower part of the neck close to the articular surface. There is destruction of the bone without new formation.

position this latter measurement and the length of the perpendicular running upwards from its tip should be the same on the two sides. Here again there is some difficulty in erecting the perpendicular from the bed and projecting it on to the body of the patient so that Bryant's triangle is scarcely more reliable than Nelaton's line. By far the most certain way of estimating the height of the great trochanter is to place the right and left thumbs on the left and right anterior superior spines and the tips of the corresponding middle fingers on the corresponding tips of the great trochanters. A mental estimation of the separation of each middle finger from the thumb is then made. Here we are concerned with the muscular sense which comes into play when we estimate the thickness of a book or the shape of an ink-pot. It is very reliable and accurate. Even a slight raising of the trochanter can be detected by this means. In measuring the length of the limb for comparison, it is essential that the angle which the axis of the limb makes with the line joining the two anterior superior spines should be the same on both sides and that this line should be at right

prominent and are a great trouble to the patient. *If the disease* progresses further there may occur an actual pathological *dislocation* of the hip joint, but, more frequently, the upper part of the acetabulum is eroded by the disease process so that the acetabulum itself becomes elongated in a vertical direction (wandering acetabulum), which leads to a considerable raising of the level of the great trochanter and a true shortening of the limb. In this stage of the disease the patient shows signs of general deterioration of his health. If an attempt is made to move the joint it will be found that it is quite impossible to do so. Restricted movement has given way to absolute rigidity and any attempt at movement causes the patient great pain. Should an abscess appear *it will*, as *a rule*, be *found to project in front in* Scarpa's *triangle*, but *sometimes an* abscess will *form in the* glutaeal region and, if the acetabulum is diseased, it will occasionally develop in the pelvis and will even be present in the ischio-rectal fossa.



Tuberculous coxitis. Left: first stage with abduction, flexion, lateral rotation and apparent lengthening. Right: second stage with adduction, flexion, medial rotation and apparent shortening. In both cases the weight is carried on the sound limb. There is wasting on the diseased side.

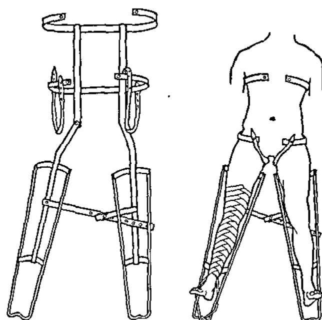
The diagnosis of tuberculous disease of the hip rests upon a series of inferences. The joint is so deep that direct signs are wanting. The important points to observe are the gradual onset, the limitation of movement in all directions and the assumption of the characteristic attitudes in the early and the late stages. In examining the hip joint an important estimation is the height of the great trochanter. This bony landmark will be raised if there is a wandering acetabulum or if there be much destruction of head and neck or a pathological dislocation. Nelaton's line is an imaginary line drawn *from the most prominent part of the great trochanter to the anterior superior spine of the ilium. The best way to mark out this* line is to have the patient lying on his back with both legs placed symmetrically with respect to the pelvis. That is, if there is abduction of the suspected side the good limb must also be abducted to the same degree. A tape measure is then wrapped over the extremity of the left middle finger which is placed under the buttock of the patient and palpates the tuber ischii through the tape. Keeping it in position, the tape is brought round to the anterior superior spine. The tip of the great trochanter *should* just come up to *the level* of Nelaton's *line. Sometimes, however, it* is normally *a little bit above* or a little bit below, the important point

may be fitted into an abduction frame so that he may be carried about and particularly, wheeled into the open air. The abduction frame should be arranged that it may be tilted slightly head downwards so that the weight of the patient's body may act as an extension weight on the limb which is attached to the foot end of the splint. It is as essential in this, as in other forms of tuberculosis, to provide the patient with abundant food of high vitamin content and give access of sun and air to his skin. The exact importance of the solar rays is a matter of controversy. Some surgeons feel that the rapid bronzing of the skin is a protective mechanism to save damage being done by the ultra-violet rays when carrying out sun treatment. Only a small area of the body should be exposed in the first instance, as too great an incidence of solar rays will depress the resistance of the patient and make him worse. Indeed it is possible that the effect of so-called sun treatment is due to cooling of the skin by exposure to the air. This continuous lowering of surface temperature increases the metabolism of the body and perhaps the activity of the immunising response. The child should be left in his splint and under this open-air treatment for a period of 18 months to 2 years, during which time the progress of the disease should be watched by X-ray photographs. It is not easy to decide when the disease has been arrested. The best guide is probably the appearance in the X-ray photograph. When the loss of density of the bone, due to the tuberculous process, has been restored, we presume that the disease is quiescent. Another very important sign of arrest of the tuberculous process is the improvement of the child's general condition. This will be noticed in returning appetite and an increase in weight. If a child with hip disease does not put on the normal increase of weight for his years or if his weight remains stationary, or if, in an adult, the weight is going down, then the disease is active. Even though the X-rays should show a check to the rarefaction of the bone or some increase in density, it may be quite certain that the patient is not cured of his disease. Another sign which has been used to tell whether there is activity or quiescence is the estimation of the sedimentation time of the red blood corpuscles. An increase in the time of sedimentation means activity of the disease and perhaps abscess formation. When it is thought that the disease has become quiescent the splint should be left off and the patient allowed a week in bed without any restriction of movement. If he has retained some movement in the joint, the range of movement will be as great at the end of the week as when the splint was removed, but should his disease not be cured, this range of movement will have diminished as a result of his freedom. This clinical test for the cure of tuberculous joints is valid for any joint

angles to the median line of the body, that is, the two limbs must be symmetrical in position. It will be deduced from this that, whilst it is possible to compare the length of two normal limbs or two limbs which are in a position of abduction, it is impossible to do it accurately when one limb is adducted because the other limb must be adducted to a similar degree, which will disturb the symmetry because it must be more or less flexed than the other owing to the crossing of the limbs.

The other conditions which must be thought of in a case of suspected hip joint disease are congenital dislocation of the hip, coxa vara and pseudo-coxalgia, which are characterised by a limp: osteomyelitis of the femur and a displaced epiphysis which are characterised by pain; and Pott's disease of the spine, psoas bursitis, hysteria and non-tuberculous arthritis which are characterised by limitation of movement. Careful consideration of the clinical features of these different conditions will show how they differ from tuberculous disease of the hip. The descriptions of these different conditions should be referred to.

The *treatment* of tuberculous disease of the hip should be begun with a period of recumbency with strapping traction by a few pounds weight. It will bring the limb into the most favourable position should ankylosis occur, that is, slight abduction, slight flexion and slight lateral rotation. If there is much flexion the pull of the weight must take place in the line of the femur, and only gradually, as the muscle spasm is overcome, will the direction of the traction be brought down to the one indicated. Night startings are usually controlled by the weight. The amount of pull needed is the smallest which will abolish the night starts. If abscesses are evident they should be aspirated and this should be done as often as the pus re-accumulates. When night startings have disappeared for a fortnight, the patient



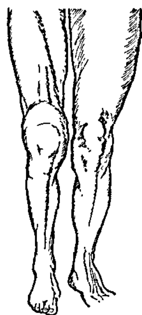
The Thomas abduction hip splint and the principle of its application. It is useful for compound fractures of the upper end of the femur as well as for tuberculous or other disease of the hip joint.

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whenever some movement is possible. If the disease has been followed by ankylosis, then the patient should be allowed up with a caliper splint which transmits the weight of his body from the tuber ischii through the upper ring of the splint to the ground. Operative treatment is very rarely required in tuberculous disease of the hip. It may be necessary when there are abscesses which are about to burst through the skin, in which case the abscess should be opened, cleared out, its wall swabbed with dry gauze and then sewn up; but, as a rule, abscesses are aspirated. It may be advisable to produce an ankylosis of the hip joint to prevent all movement. This is done by leaving the actual joint structures alone, and turning down a piece of bone from the surface of the ilium and attaching it to the great trochanter which has been bared of periosteum to receive it. A rigid buttress is thus erected between the ilium and the femur (extra-articular arthrodesis).

Tuberculous Disease of the Knee Joint

This again is associated with limping and tiredness of the limb, and pain after prolonged exertion. There are great wasting of the thigh muscles and a swelling of the joint, which, being due to the transformation of the synovial membrane, capsule and periarticular structure into granulation tissue, has lost all the peculiar contours of the synovial cavity. The knee joint is flexed. It is not possible to extend it completely nor to bend it up as far as on the normal side. If the joint is felt it will be perceived that it is hot to the fingers and it has a peculiar soft consistency. Only very rarely is there fluid in a tuberculous knee joint, and then only at the very beginning of the disease; even so there will be a pronounced thickening of some part of the synovial membrane. If the disease proceeds without treatment, night startings will come on and, when the capsule has been destroyed, a pathological dislocation will occur, the tibia dropping backwards and outwards and being externally rotated. Abscesses usually appear in front of the sides of the patella.



Tuberculous knee. Note the loss of characteristic shape of the joint, the wasting of the thigh muscles and of the leg.

The diagnosis of tuberculous disease of the knee can be made certain by removing a piece of synovial membrane for microscopical

examination. Unfortunately, this procedure is likely to be followed by a persistent sinus so that it should only be exceptionally performed. If a gland from the groin be removed it will frequently be found to contain tuberculous lesions.

Treatment.—In the early stages, besides general treatment as described under the hip disease, the limb should be immobilised in a plaster of Paris casing. If there are night startings, strapping traction should be applied, and in this case it is as well to apply a plaster splint also. Persistent flexion can be overcome by weight traction. The pull must be in the line of the tibia. This is done by suspending the limb to an overhead beam so that the tibia lies horizontal. Gradually the limb can be lowered as the deformity is corrected. Abscesses must be aspirated when they occur. The treatment of a tuberculous knee lasts as long as that of a tuberculous hip and the signs of arrest are the same. When the patient is allowed up he should wear a caliper splint for a long period.

An operation for tuberculous disease of the knee joint is frequently advisable in the quiescent stage because a rigid bony ankylosis is brought about which will stand the strains of weight-bearing. A typical excision of the joint is usually performed. In children, up to 15 years of age, this is an objectionable operation because the growth of the limb is almost certain to be interfered with. It has a greater place in the surgery of adults. In these latter, over the age of 45, the question of amputation should always be considered because the power of recovery from a tuberculous joint diminishes with age and the outlook in the case of the lower limb is much worse than in the upper limb because of the great strain to which the joint is subjected in carrying the weight of the body. The patient may avoid a very long illness and be restored to useful life, often much more rapidly, if he has an amputation than if conservative treatment is adopted. This applies also to tuberculous disease of the ankle and foot in middle-aged adults, but does not apply to tuberculous diseases of the joints of the upper limb. When there are persistent sinuses which will not close, an amputation is sometimes the best treatment both in children and adults. It removes the site of the disease and the possibility of amyloid complications. Excision of the knee joint should never be carried out when there is a secondary infection present.

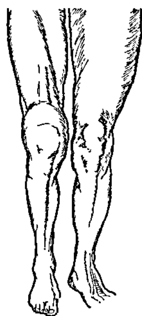
Tuberculous Disease of the Ankle Joint and Tarsal Joints

The characteristic of tuberculous disease of the ankle and tarsus is that there is the same insidious onset with a white swelling which obliterates the normal anatomical contours of the ankle and foot.

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In other cases there is very little alteration in the synovial membrane itself, the bulk of the disease process affecting the bone ends, which are gradually destroyed. To this variety of the disease the name of caries sicca is given.

In caries sicca the wasting is far and away the most pronounced feature of the disease. The spine of the scapula stands out strongly and the deltoid almost disappears, so great is the wasting. There is spasm of the muscles acting on the joint so that all movements are very much restricted, or even abolished. Ankylosis is nearly always the end-result of tuberculosis in the shoulder and the best position for the arm to be in is at 45° with the body. It had better be fixed in this position by a plaster of Paris casing and the early part of the treatment had better be carried out with the patient in bed. When he gets up, the question of a splint presents difficulty because there exists no really efficient abduction splint. The apparatus is so apt to slip and put a strain on the joint instead of relieving it of all stress. Plaster of Paris is really too heavy for the patient to go about in; it is probably better to provide him with one of the light aluminium or duralumin splints.



Tuberculous disease of shoulder joint. There are two sinuses and an area of scrofuloderma.

Tuberculous Disease of the Elbow Joint

Here the disease forms a spindle-shaped white swelling of the elbow joint which assumes a position of flexion. There is very great wasting of the upper arm. There is greatly restricted movement of the elbow joint and perhaps considerable pain. The disease is best treated by encasing the upper limb in plaster which must reach from the axilla to the middle of the palm. The elbow joint should be at a little less than a right angle. Abscesses are treated as indicated above and criteria of cure are the same. The prognosis is better in tuberculous disease of the upper limb than in joints of the lower limb.

Movements of the ankle joint and the mediotarsal joints are restricted, the soft *thickened synovial* membrane can be palpated and there is

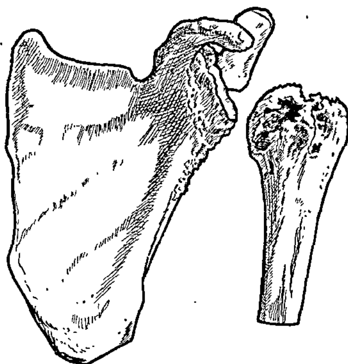


Tuberculous disease of ankle joint.

pain after use. The X-rays frequently show that the disease has begun in the astragalus. The best local treatment is to encase the limb in plaster of Paris. In adults amputation of the foot in the lower third of the leg is often the best treatment.

Tuberculous Disease of the Shoulder Joint

This occurs in two forms. Sometimes there is a white swelling of the shoulder joint which is characteristic of the knee and hip,



The bones from a tuberculous shoulder. There is the characteristic erosion of bone with very little new formation.

associated with considerable proliferation of the synovial membrane of the joint so that there is swelling of that region under the deltoid.

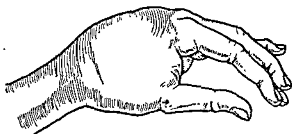
Treatment: Very little can be done directly curative in rheumatoid arthritis but deformity can be prevented by proper splinting during the acute stages. At the beginning of the disease the patient had better be in bed with traction applied to the lower limb, if that is affected. In the upper limb the joints should be placed in those positions which are most favourable should ankylosis occur. Search should be made for localised seats of infection and they should be removed if it is thought they are causative lesions. In local treatment heat is probably better than anything else; radiant heat and particularly diathermy are recommended. Splinting is necessary until the acute stage has been passed. The patient is likely to have exacerbations, however, which must be treated in the same way. The injection of foreign proteins to cause pyrexia sometimes leads to improvement in the condition of the joints.

Osteoarthritis is a disease of late adult life and does not occur in young people. Its cause is quite unknown but injury does play some part in it. It may be monarticular. Osteoarthritis affects the large joints rather than the small joints. It begins insidiously without the acute onset associated with rheumatoid arthritis. There is a certain stiffness in the joints in the morning which wears off with exercise. Fluid may be present in the joint but, as a rule, there is not very much. The synovial membrane is thickened and the villi hypertrophied so that they can be frequently rolled under the finger. The cartilage is fibrillated and then worn away so that, in the elbow joint, grooves may occur from the movement of bones on one another. At the edges of the cartilage there is proliferation so that the cartilage is increased, and in this ossification may occur, the result being the formation of bony nodules called osteophytes. Patients with osteoarthritis have thickenings on their fingers at the middle and terminal interphalangeal joints. These nodules, called Heberden's nodes, are at first composed of thickened connective tissue but, finally, some bone may grow into them from the articular margin. There is no constitutional upset in osteoarthritis.

Treatment: There is no known remedy for osteoarthritis but osteoarthritic joints should be protected from injury and should have their movements restricted but not prevented. Strapping applied to the joint will give it perhaps just the necessary amount of support and limitation to its activity. It is not so useful here to treat local sources of infection, though, of course, if they are removed the general health of the patient will improve. The joints never become ankylosed but movement may be very limited by the presence of osteophytes. When pain is very severe it is sometimes wise to perform an arthrodesis. A treatment which has been tried in a few cases is the drilling of

Tuberculous Disease of the Wrist Joint

The disease here may begin in the lower end of the radius or one of the carpal bones. There are great wasting of the forearm muscles and a white swelling in the region of the wrist which obliterates the anatomical shape. The wrist has a tendency to assume a flexed position.



Tuberculous wrist.

Treatment is immobilisation in plaster of Paris with the wrist in the dorsiflexed position by a casing which reaches from the upper third of the forearm to the heads of the metacarpal bones.

Arthritis Deformans

Under this term are included a number of different affections of joints which have this in common—they are all chronic and have obscure aetiology. It is helpful to separate these chronic arthritides into two main groups: (1) rheumatoid arthritis; (2) osteoarthritis.

Rheumatoid Arthritis is a disease of young adults, middle life or even children. It is supposed that it is due to a focus of infection somewhere in the body, such as those which occur at the roots of teeth, in the tonsils, in the accessory sinuses and in the bowel. The infecting organism may be a *Streptococcus viridans*. On the other hand it is just possible that the condition of the joint is due to the toxins of the organisms circulating in the blood and not to the organisms themselves. The disease often begins acutely and affects a number of joints. There are pain, effusion and stiffness. The pathological changes are rarefaction of the bone ends, fibrillation and gradual disappearance of cartilage and an inflammatory process in the capsule, ligaments and peri-articular structures. There is no new bone formation. The acute stage may settle down into a prolonged chronic affection. The result is great crippling of the joint, which becomes flexed and frequently distorted. In the case of the small joints of the fingers, ulnar deviation is very common, the knee joint contracts right up and the hip joint becomes adducted and flexed. The elbow joint is flexed and the wrist joint too. The joints of the spinal column and the sternoclavicular joints are frequently involved. In children a similar condition occurs and is known as Still's disease. It is sometimes accompanied by a temperature and nearly always by a rapid pulse. The lymphatic glands are enlarged.

Treatment: Very little can be done directly curative in rheumatoid arthritis but deformity can be prevented by proper splinting during the acute stages. At the beginning of the disease the patient had better be in bed with traction applied to the lower limb, if that is affected. In the upper limb the joints should be placed in those positions which are most favourable should ankylosis occur. Search should be made for localised seats of infection and they should be removed if it is thought they are causative lesions. In local treatment heat is probably better than anything else; radiant heat and particularly diathermy are recommended. Splinting is necessary until the acute stage has been passed. The patient is likely to have exacerbations, however, which must be treated in the same way. The injection of foreign proteins to cause pyrexia sometimes leads to improvement in the condition of the joints.

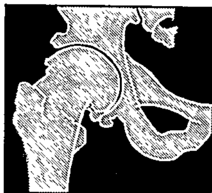
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the bones in the neighbourhood of the joint. It is said to relieve the pain. For the knee joint the outer side of the lower end of the femur or the inner side of the upper end of the tibia are trephined with a ¼-inch trephine.

Osteoarthritis of the Hip Joint (Morbus coxae senilis)

This joint is particularly likely to be affected by osteoarthritis. It is accompanied by pain, and adduction soon appears so that the great trochanter becomes prominent. The great trochanter may also be raised because the upper margin of the acetabulum is worn away at the same time as the head of the femur. The joint, from being an enarthrosis and so allowing circumduction, is changed into a ginglymus, that is, rotation and abduction of the hip joint are lost whilst flexion and extension are still comparatively free. The pain is sometimes so great that an arthrodesis is called for, but sometimes fitting the patient with a caliper splint which will relieve the joint from the strain of weight-bearing will be equally effective. The hip joint is a difficult one to cause to ankylose, even in young people. In old subjects, where ossification is sluggish and frequently fails, it is not always wise to try to produce an ankylosis. More success has been obtained by combining extra-articular arthrodesis with the intra-articular operation. No relief is obtained unless the ankylosis is of the bony variety. Some good accounts of drilling the neck of the femur from the base of the great trochanter to relieve the pain in osteoarthritis of the hip have been recorded.



Skiagram of osteoarthritis of hip.

Arthritis of the Menopause

This is a condition which resembles osteoarthritis and comes on in women of 45 to 50 years of age. It is also seen in younger people after hysterectomy. The condition may clear up to a considerable extent after having been present for a year or two.

Haemophilic Joints

Haemophilic affections of joints are due to the effusion of blood into the joint cavity. The condition, of course, only occurs in

haemophilic subjects, that is, in boys whose maternal grandfathers have suffered from the disease. The knees are the joints particularly affected. The haemarthrosis comes on with a very slight injury. It is usually painless and causes a certain amount of inflammatory reaction, as evidenced by increased heat. Recurrent attacks occur and each time there is a certain amount of thickening of the synovial membrane left, so that, after a time, the joint comes to simulate rather closely a tuberculous infection of the knee joint. The diagnosis can only be made by the history of haemophilia and perhaps the finding of bruises on other parts of the body. There is no treatment except the splinting of the joints and the protection from further injury.

Gouty Arthritis

This disease is really only of surgical interest from the point of view of diagnosis. It occurs typically in the metatarso-phalangeal joint of the great toe, but may occur in other joints, particularly in the small joints of the hand. It occurs very acutely so that there are heat, swelling, redness and great pain in the joint, and shows curious daily remissions, the exacerbations occurring usually in the mornings. The condition is due to the deposition of uric acid crystals in the connective tissue round the joint and the consequent irritation with the formation of scar tissue. This leads to a good deal of peri-articular cicatrisation and deformity. Deposition of urates may occur in the scar tissue and be visible to the naked eye and, perhaps, ulcerate through the skin (tophi). These tophi are seen particularly in the ears as well as round the joint. The X-ray shows big punched-out areas of erosion round the bone.

Neuropathic Joints

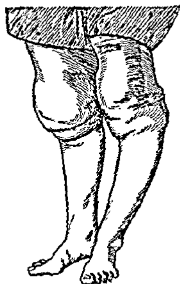
Particularly in two diseases of the spinal cord, namely locomotor ataxia and syringomyelia, affections of the joints are likely to occur. They were described first by Charcot. These changes in the joints are seen in the lower limb in locomotor ataxia and in the upper limb in syringomyelia. They also occur rarely in lesions of the peripheral nerves. The exact relation of the joint affection to the nervous condition is not known but it is supposed that anaesthesia of the joint allows injuries to occur unheeded, which start the pathological processes. There must, however, be another factor present because the changes which occur are seen in no other condition. Charcot's joints may come on very rapidly. Even in a night a joint may become suddenly distended with fluid and disorganisation very

quickly follows. The capsule and ligaments appear to degenerate and the bones become rarefied so that they wear away very quickly. At the same time, beyond the joint where the bones are not subjected to pressure there may be extensive formation of new bone. If, however, the bones are radiographed it will be found that they are rarefied. There is no sclerosis as seen in the osteoarthritic joints. The amount of fluid poured out into the joint may be enormous. Large swellings may occur in the region of the hip joint and pathological dislocation from the distension produced. The same applies to the other joints.

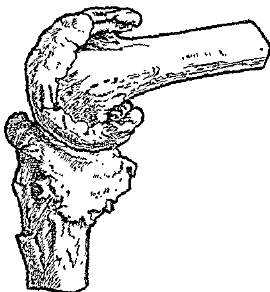


Syringomyelia showing a Charcot's disease of the shoulder joint, a paralysed trophic hand and widespread muscular wasting. The long head of the biceps muscle is ruptured.

Everything is on a large scale in Charcot's disease. There are abundant effusion of fluid, unusual destruction of the bones and great new formation of bone. The diagnosis of Charcot's disease is quite easy because, in spite of this exaggeration of all pathological changes, there is complete absence of any pain, so that the joint can be moved very freely in any direction although accompanied by the most alarming grating of



Neuropathic arthritis of both knees. They are both dislocated backwards.



The bones of a neuropathic knee joint (Charcot's disease).

which the patient is placidly aware, and because of the demonstration of a disease of the central nervous system, locomotor ataxia in

the case of the lower limb, syringomyelia in the case of the upper limb. There is no treatment for the joint itself. Tabes may be influenced by anti-syphilitic treatment and hyperpyrexial therapy. The joints can only be protected from harm by splints which also give them support.

Hysterical or Mimetic Joints

These joints are only seen in women and children and are the result of the suggestion of joint disease in the patient's mind. She has perhaps been in contact with a friend who has had a tuberculous hip or chronic disease of the knee joint. They are sometimes rather difficult to diagnose. There is a persistent limp and the patient complains of pain. On examining the joint there is a limitation of movement and spasm of the muscles. If, however, care is taken in the examination the diagnosis usually becomes clear. The hip joint, for instance, will assume a position which is not seen in any known arthritis. The muscular spasm may disappear when the patient's attention is diverted from the joint. If an anaesthetic is given, the muscle spasm quickly goes and the joint becomes freely movable in any direction. There may be other stigmata of hysteria: for instance, the visual fields may be limited concentrically and there may be some anaesthesia of the pharyngeal wall, or perhaps patches of anaesthesia may be found in the limbs. The X-ray is completely negative.

In the treatment of this condition it is important to divert the patient's attention from the joint. No splints should be used. Rather should she be encouraged to exercise the joint. Psychotherapy may be of use.

CHAPTER XLII

DISEASES OF MUSCLES AND TENDONS

Injuries

Rupture of muscle takes place from severe trauma occurring when the patient is taken off his guard, so that the muscle, when in a state of contraction, is subjected to sudden strain. It is not very often that the belly of the muscle gives way. The tear usually takes place at the junction of the muscle with its tendon, or close to the insertion of the tendon. The rectus abdominis is ruptured in accidents, occasionally during parturition and sometimes in a tetanic spasm of tetanus. The tear is usually subumbilical in situation. The quadriceps is liable to be torn when the patient tries to save himself from falling backwards. The muscle itself may tear, or the tendon above the patella, or even the ligamentum patellae. The sternomastoid is ruptured during birth and the adductor muscles in riding accidents. The muscles of the calf sometimes give way apparently to a very slight strain. The patient will experience a sudden pain in his calf and frequently think that something has hit him. Rarely the whole tendo Achillis is ruptured but, much more often, it is a partial tear of the gastrocnemius or a tear of the plantaris. The biceps cubiti can be torn when a man, in falling, tries to save himself with a hooked arm. Either the long or the short head of the muscle may give way. The tendon of the long head of the biceps is apt to become degenerated in osteoarthritis of the shoulder joint and so rupture with very slight violence.



Ruptured long head of biceps.

Rupture of a muscle is usually easily diagnosed because of the localised pain, the swelling from the haematoma, and the appearance

of a tumour when the muscle is thrown into contraction. The movement performed by the muscle is either abolished or very much weakened. In the treatment of the condition it is essential to operate soon after the accident as, if weeks are allowed to elapse, the muscle may be so shortened by contraction that it is impossible to bring the two ends together. *In the case of the biceps cubiti the long tendon* is not usually repaired but the distal end sutured to the periosteum *of the upper end of the humerus, so that this head of the muscle has* a new origin. When the muscle fibres are actually torn across, the suture must be carried out with stitches of the mattress type or they will pull through. Rupture of the quadriceps extensor tendon, or the ligamentum patellae, will need, after suture, prolonged immobilisation before it will be safe to subject them to great strain.

The common back injury, in which some of the attachments of the erector spinae muscles are torn, is treated by obliquely crossing overlapping strips of strapping, applied over the affected area and well above and below. This may be sufficient immobilisation to allow repair to take place. In bad cases rest in bed becomes necessary.

Hernia of Muscle

Sometimes patients are met with in which there is a gap in the deep fascia of the limbs, through which a soft projection of muscle protrudes. This projection disappears when the muscle is thrown into contraction. The gap in the fascia can be felt. The hernial aperture seems sometimes to be a congenital defect but in other cases it is supposed that trauma causes a tear. If pain and weakness is complained of, the opening in the fascia should be sutured, but very often no treatment is required.

Dislocations of Tendons

The only common injury of this kind is a luxation of the peronei tendons from their groove behind the fibula. In some accident in which the foot is strongly inverted, the retaining fascia is torn and the tendons slip out of their groove on to the surface of the malleolus. Tendons are easily replaced but repeated dislocations are extremely common.

The treatment is to expose the tendons and suture a flap of periosteum obtained from the fibula over the groove. If necessary, a piece of fascia lata may be used for this purpose.

Tennis Elbow

This is an injury to the arm, the result of repeated strains, which expresses itself by a sudden sharp pain felt in the region of the elbow joint on the performance of some particular movement. The movement which calls forth the pain may be quite a small one and need not be forcible. The elbow is able to carry out other movements with undiminished strength. There is always a tender area in the region of the outer side of the elbow joint, sometimes over the head of the radius, but more often at the attachment of the extensores carpi radiales to the supracondylar ridge.

The exact pathology of tennis elbow is not accurately known. More than one injury seems to come under this designation. The commonest derangement seems to be a tearing of some muscle fibres of the radial extensors from their attachment to the humerus. The next commonest lesion would appear to be damage to the orbicular ligament which holds the head of the radius in the coronoid fossa. The injury is very disabling. It will last for many months but in the end it nearly always disappears, even without treatment. If rest to the elbow joint, produced by strapping it, does not give relief, manipulation under anaesthesia very likely will. The object of manipulation is to tear the injured muscle fibres right from their attachment. It will be found that complete extension of the forearm in the pronated position with the wrist flexed is not possible without causing a great deal of pain. So, under anaesthesia, the wrist is flexed, the forearm pronated, and the elbow joint forcibly extended while the supracondylar lesion is kneaded with the thumb. After this procedure there may be some local reaction and pain felt for a fortnight, but after this the condition will clear up. Whilst the wrenching is taking place a click is sometimes heard or felt. It would appear to occur in those cases where the disability is due to an injury of the orbicular ligament and the interposition of the frayed edge between the articular surfaces. When this structure is freed a click is produced and the patient is cured.

Snapping Hip

This is a condition in which, on some movement of the hip joint, usually rotation when the muscles are in contraction with the patient standing, an audible click is heard. This click can very often be produced voluntarily.

Sometimes it causes no disability at all and can be disregarded, but in other cases there is some pain and weakness at the hip joint.

If the hand be placed over the trochanter when the snap takes place it can be felt to be due to the slipping of a fibrous band in this situation. It is indeed due to movement of the ilio-tibial band over the surface of the trochanter.

If necessary, it can easily be cured by suturing the ilio-tibial band to the periosteum of the anterior aspect of the great trochanter.

Myositis

Myositis is the inflammation of muscular tissue.

Pyogenic Myositis

Muscles may become inflamed by the spread of an infection from a neighbouring focus, such as a joint, a lymphatic gland or the bone in osteomyelitis. They may also become infected by penetrating injuries. In pyaemia abscesses are liable to form among the muscles, particularly in those of the thigh, the infection being through the blood-stream. Such abscesses are very insidious in their onset and liable to be overlooked.

The treatment of septic myositis is usually carried out as part of the treatment of the underlying condition. When an abscess forms in pyaemia, it should be drained.

Rheumatic Myositis

Rheumatic myositis is the name given to inflammation of muscles of uncertain origin. There is probably no true connection with rheumatism. The condition may be due to what is called a sub-infection with pyogenic organisms, or to the action of toxins absorbed, perhaps from the alimentary canal, or from some focus of infection elsewhere in the body. Examples of this are seen in the severe pain and swelling which occurs in the sternomastoid, causing the head to be turned to one side (rheumatic torticollis), in attacks of lumbago and stiff neck. In all these cases the patient suffers from slight symptoms of toxaemia; his temperature may be a little raised, and there is exquisite tenderness and swelling of the muscles concerned. Gentle massage and the application of heat are the best remedies for these conditions, whilst the administration of sodium salicylate internally may help. The patient with lumbago may actually have to be kept in bed or, if he is about, strapping may afford him some relief. The overlapping strips of strapping should cross each other in an X-shaped fashion over the painful area and beyond it.

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fixing the jaw and the diaphragm and interfering with respiration. The children often suffer from microdactylia, particularly of the thumbs. Sometimes, also, there are osteomata in the bones. There is no known treatment. The patient, as a rule, succumbs to an attack of broncho-pneumonia.

Trichiniasis

This disease is not very common in this country but is of more frequent occurrence in Germany, and is associated with the consumption of so many pork sausages. It is due to the nematode worm which normally inhabits the rat but is conveyed to human beings by infected pork. The worms are of a very small size, the female being only 4 mm. in length. The worms in the pig's flesh entering the alimentary canal of the human being give rise, after 7 or 8 days, to embryos which pass through the intestine into the lymphatics and enter the muscles, where they become encysted in the striated muscle fibres. They may live here for years or they may die and become calcified.

Symptoms begin with a gastro-intestinal attack which is followed by a febrile period when the embryos migrate. The muscles become painful, swollen and tender. There may be some oedema of the overlying skin, and itching is complained of. Any of the muscles in the body may be affected so that eating, breathing and talking may be interfered with. This acute period lasts 2 or more weeks. There is an eosinophilia. The embryos may be discovered in the faeces. There is no known treatment for the muscles but the worms in the intestine should be got rid of by aperients and vermifuges.

Syphilitic Myositis

This occurs as a tertiary lesion and may be a diffuse gummatous infiltration of the muscle, affecting particularly the biceps, the sterno-mastoid or the masseter; or it may be the simple formation of a gumma in the substance of the muscle. The diffuse form causes a stiffness and contraction of the affected muscle. It is one of the causes of trismus. The gummata form isolated tumours in the muscles with very great disturbance of function. If they happen to extend and reach the surface, a gummatous ulcer results.

The diagnosis of syphilitic myositis can only be made by finding other signs of syphilis or a positive Wassermann reaction. It is very amenable to anti-syphilitic remedies.

Myositis Ossificans Traumatica

Myositis ossificans traumatica is an ossification which occurs in muscles or in the sheaths of muscles, following some damage to the muscle tissue. It is met with particularly in the brachialis anticus and in the triceps, following fractures of the lower end of the *humerus* or dislocation of the elbow. It is also seen in the adductor longus. As rupture of the adductors occurs most commonly as the result of riding accidents, ossification of the muscle has been called "rider's bone".

Myositis ossificans traumatica has frequently been thought to be due to a tearing of the periosteum, which allows a migration of osteoblasts into the neighbouring muscle. This appears a likely explanation when it occurs in the adductor longus, or as the result of fractures of the arm, but it does not seem to account for the ossification which sometimes takes place in the sheath of the rectus after paramedian laparotomies, *for it may occur in this situation when the incision has* neither extended up so far as the ensiform process nor down to the pubis. It is supposed that embryonic connective tissue cells in the repair of the wound have undergone a metaplasia into osteogenic cells. Myositis ossificans is more common in children than in adults. It may lead to the formation of masses of bone in the biceps or triceps of considerable size, which may interfere with the movement. In the *treatment of such a condition absolute immobilisation of the elbow* joint is essential. Any movement or massage tends to increase the bone formation, whilst it has been observed that if absolute immobilisation in plaster of Paris is carried out, the ossified areas sometimes diminish in size. Operation is very seldom called for. Removal of the bone is liable to be followed by recurrence but, in late cases where some interference with movement is present, excision of the bone and some surrounding tissue is justified. When the disease occurs in other situations treatment on the same lines is indicated.

Myositis Ossificans Progressiva

This rare disease occurs in children and leads to death in early adult life. It begins with a subacute attack, usually in the back muscles, where tender swellings appear. *These swellings do not* resolve but gradually become transformed into plates of osseous tissue. One attack after another appears; each time the ossification extends; ultimately most of the muscles in the body become rigid, including the face muscles, the tongue and the muscles of mastication, *thereby*

fixing the jaw and the diaphragm and interfering with respiration. The children often suffer from microdactylia, particularly of the thumbs. Sometimes, also, there are osteomata in the bones. There is no known treatment. The patient, as a rule, succumbs to an attack of broncho-pneumonia.

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Gonococcal Myositis

Gonococcal myositis occurs as a rule in association with gonococcal arthritis.

Tuberculous Myositis

Tuberculous myositis occurs as the result of a spread of tuberculous infection from a lymphatic gland or a joint.

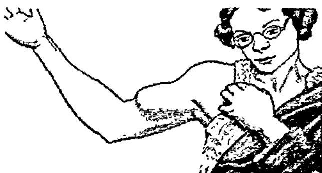
Tumours of Muscle

Not very many tumours arise in muscles. The innocent tumours are angiomata, lipomata and fibromata. The malignant tumours are sarcomata.

Angiomata form soft ill-defined swellings in the muscles which diminish in size on firm pressure. Sometimes they are lymphangiomata. In any case they should be removed as they have a great tendency to spread, and, when large, the removal becomes a very serious operative procedure on account of haemorrhage. The whole muscle concerned may have to be taken away.

Lipomata grow from the connective tissue between the muscles. They form soft fluctuating swellings in the substance of the thigh muscles or the muscles of the arm or hand. They simulate very strongly cold abscesses coming from some underlying tuberculous infection of the bone, and the diagnosis may not be certainly made until the actual operation.

Fibromata are rather uncommon. As a rule, they are small tumours which grow from the sheaths of muscles. The particular variety growing from the rectus sheath is called a desmoid. It forms a hard tumour attached to the anterior rectus sheath and is of interest from the fact that it is very prone to recur after removal, though metastases are almost unknown (see page 328).



A sarcoma growing from the sheath of the biceps muscle.

Sarcomata, which grow in muscles, also arise from the cellular tissue between the muscle fibres and may occur in any of the limbs. They form painless hard tumours, slowly increasing in size, ultimately interfering with the movement of the joints. The skin over these tumours often shows dilated veins coursing through it.

Wide excision of these tumours is the treatment. If met with in a late stage when they have invaded nerves, causing intolerable neuralgia or paralysis, amputation is necessary. The outlook after removal of a sarcoma of the muscles is not nearly so bad as in the case of sarcoma of one of the long bones.

TENOSYNOVITIS AND TENOCELLULITIS

These are conditions in which the synovial sheath or the loose tissue round a tendon becomes inflamed. The reaction to irritation in the tendon itself is not very active because of the poor blood-supply of the tissues composing it.

Tenosynovitis is most commonly traumatic in origin. In the upper limb it is seen particularly round the extensor primi internodii pollicis and the extensor ossis metacarpi pollicis tendons as they cross over the lower part of the radius, and follow strains such as that due to excessive screw-driving, or the wringing of clothes by washer-women. A tender swelling is formed along the course of the tendons and any movement in which these muscles come into play gives rise to pain. At some time during the course of the disease a soft crepitus can be felt on palpation when the tendons move.

The best *treatment* is to apply a light anterior plaster splint which extends from the upper third of the forearm to the middle of the palm and gives support for the thumb. In milder cases it is sufficient to strap the area of the swelling. The condition usually subsides in about 2 weeks. Another common situation for tenosynovitis is the dorsum of the hand, where a triangular-shaped swelling forms, accompanied by the same symptoms and signs. Here also an anterior splint extending into the palm is effective treatment.

Tenosynovitis of this nature may affect almost any tendon but, in the lower limb, it is found particularly in the tendons running in the neighbourhood of the ankle joint, rather specially the peronei tendons. Strapping of the ankle joints is the best treatment.

Other forms of tenosynovitis occur, particularly gonococcal tenosynovitis, associated with gonococcal arthritis.

Tuberculous tenosynovitis occurs as an extension from tuberculous disease of the joints, but it also occurs as a primary infection, particularly in the hand where it is only rarely associated with a bone lesion. The tuberculous process may affect the flexor sheaths or the dorsal tendons. In the case of the flexor tendons two varieties are met with; one in which there is a sero-fibrous exudation, in which the anterior carpal sheath is distended with fluid and contains bodies about the size of melon seeds, and very much like them in appearance, com-

posed of fibrin; and the other the so-called white swelling of the tendon sheath, in which the walls of the sheath are converted into thick tuberculous granulation tissue. The deep, as well as the parietal, layers of the sheath are affected. The tendons, for a considerable time, escape invasion, but later on the granulation tissue grows into them and may cause destruction of certain tendons, so that they give way under the slightest strain. The disease is a very chronic one and it has been found that tendons are always affected when it has lasted for a year, and one, or more, has always been destroyed when the disease has lasted three years.

The patient first complains of a stiffness on moving the fingers and later much pain. Then there is noticed a swelling which is evident particularly on the front of the wrist, above the anterior annular ligament. This can also be appreciated in the palm, though here it is not so obvious because of the thick palmar fascia. If there is fluid in the sheath, fluctuation can be elicited from above the wrist to the palm, and at the same time pressure on the swelling may reveal a crepitus from the melon-seed bodies rubbing together. When there is no fluid, the white swelling has a soft feel and its limits are very ill-defined. This variety of tenosynovitis may proceed to the formation of a cold abscess which reaches the surface as a typical tuberculous fistula. Sometimes there is an accompanying median neuritis, causing pain, numbness or tingling in the distribution of this nerve.

Treatment.—There is some difference of opinion as to the correct treatment of this condition. It is certainly true that many cases will recover with prolonged immobilisation. If the immobilisation treatment is carried out it is essential that the plaster of Paris splint should reach to the tips of the slightly flexed fingers and the tip of the thumb. Unless all movement of the fingers is prevented, healing will be very much delayed. The whole treatment will take 18 months to 2 years. Some surgeons advocate operative treatment as a routine, holding that conservative treatment is likely to result in more stiffness. But very good movement can be obtained by conservative treatment and, on the other hand, after operative treatment sometimes considerable interference with movement remains. If operative treatment is undertaken it must be a thorough radical removal of all the tuberculous tissue. This means that not only must the parietal but the deep layer of the synovial membrane be removed. Diseased areas in the tendons will very likely necessitate tendon suture. On the whole, it would seem that the best course to adopt is to make a trial of conservative treatment at the beginning. As soon as immobilisation is effected often a very rapid improvement takes place. If it does,

then operation need not be resorted to. When the tenosynovitis affects the dorsum of the hand a very similar clinical condition occurs. There is a triangular thickening on the dorsum of the hand extending up into the forearm corresponding with the dorsal sheaths. Treatment is undertaken on the same principles.

Volkmann's Ischaemic Contracture

This is a condition which follows fractures of the lower end of the humerus or fractures of the forearm bones. It is a slowly developing fibrosis of the muscle tissue which affects the flexors and pronators and causes a permanent shortening of the muscles, and so interferes with their movements. There is actual degeneration of muscle tissue which becomes replaced by fibrous tissue, but it is patchy in distribution. Finally, vessels and nerves become embedded in the fibrous tissue so that there are frequently accompanying nerve symptoms and vascular changes.

The cause of the condition is not certainly known. It is not due to a simple interference with the arterial distribution, nor is it simply due to obstruction of the venous return. Neither of these factors, in itself, will produce a typical contracture. But in the conditions in which it occurs there is always present extensive laceration and haemorrhage into the tissues, so that there may be obstruction of the lymphatic and venous return as well as possibly interference with the arteries.

A typical example occurs when, in a child, after a supracondylar fracture of the lower end of the humerus, the arm has been put up in a position of maximum flexion. The condition begins with very great pain which is often attributed by the patient to the fracture itself. Accompanying this there are swelling and oedema of the arm and hand which assumes a dusky blue colour. If the radial pulse is felt for it will be found to be absent or almost imperceptible. The power of voluntary movement of the fingers is lost. All these changes take place within the first few hours after the fracture has been put up. Paralysis at first is flaccid in nature, but as the contracture of the muscles gradually sets in, after about 2 weeks, the muscles become very hard. It has been already mentioned that the flexors and pronators are alone involved in the condition. When it is established the two terminal phalanges of the fingers are flexed. The thumb, with its terminal joint bent, is usually kept in the same plane as the fingers. There is some extension at the metacarpo-phalangeal joint and the forearm is pronated. This claw hand is accentuated if the ulnar nerve is affected at the same time. Trophic changes of the skin may

be present in the earlier stages, but they disappear later on. It will be found that the fingers can be straightened out if the wrist is flexed, but when the wrist is extended they come into their original position of flexion again.

Treatment.—Although the exact nature of the process is not quite clear, it is certain that it depends upon an increase of tension beneath the deep fascia. This is certainly assisted by tight splinting or too acute flexion of the elbow joint, so that, when the premonitory symptoms have appeared and the fracture is one of the lower end of the humerus or the forearm bones, the first step should be the removal of all splints or bandages. The limb should be allowed to rest on a pillow, raised a little bit above the level of the patient, to assist the venous return. If the colour of the limb does not improve, if the radial pulse does not become perceptible, and the pain persists, then further measures must be taken to relieve the pressure beneath the deep fascia, by making incisions into it and leaving the wound open. In established cases the best treatment, as a rule, is gradually to stretch the affected muscles. Owing to the patchy distribution of the fibrosis, which has been mentioned above, the paralysis is not complete, so that if the contracted tissue can be stretched, a very useful arm remains. A malleable metal splint is applied to each of the fingers and the thumb and, day by day, the joints are brought into a more fully extended position. When the fingers have been straightened the splint is changed for one which extends along the palmar surface of the forearm, retaining the fingers in the extended position. The bent wrist is gradually undone until it reaches full hyperextension. Much the best results have been obtained by this slow method of restoration of movement.

In very old and inveterate deformities surgery is sometimes required. The simplest surgical procedure is to strip the flexor group of muscles from their attachments to the internal condyle of the humerus. This will allow a lengthening of about $\frac{1}{2}$ to $\frac{3}{4}$ of an inch, no more because of the nerve attachments. Sometimes a tendon lengthening has been performed, particularly a lengthening of the flexor carpi ulnaris and the flexor carpi radialis and the flexor longus pollicis, while at the same time the pronator radii teres is divided. For the worst cases bone resection has been performed. Shortening the forearm bones is an obvious way to overcome the difficulty but not a very good one, because of the difficulty in getting a good result from the fractures which are produced. Excision of the distal row of carpal bones has been recommended as a better procedure.

CHAPTER XLIII

DISEASES OF BURSAE

The surgery of bursae includes not only the diseases of the normal anatomical structures under this heading, but those of adventitious formation. Adventitious bursae are really greatly enlarged lymphatic spaces which form in regions subjected to abnormal pressure. The bursa which forms where the shoe presses over the enlarged head of the first metatarsal bone in hallux valgus is an example. Bursae also form over the acromion in men who carry heavy weights upon their shoulders, and are seen on the outer side of the foot in bad, neglected cases of talipes equinus varus. Wounds of bursae sometimes occur and are troublesome because they may be very long in healing; in fact, it is sometimes necessary to excise the bursa in order to induce the wound to close.

Traumatic Bursitis

Traumatic bursitis occurs, as a rule, from repeated injuries. It is seen very often in the prepatellar bursa in scrubbers, or other people who kneel and lean forwards at the same time (housemaid's knee).

The bursa becomes enlarged, tender and fluctuant. The contents of the bursa are a yellow serous fluid, but sometimes clotting takes place, so that a thick inner lining of fibrin is formed. An injury may also cause a haemorrhage into a bursa and the blood to clot.

In the treatment of prepatellar bursitis it is essential that the patient should stop kneeling for a time in order to give the bursa absolute rest. It is a good plan to apply a Cramer back splint to the knee. If, at the same time, the bursa is aspirated and compressed with strapping, the condition will often be cured. In order to prevent a recurrence of the affection the patient should have a pad to kneel upon. In cases of relapse and persistent or recurrent effusion into the prepatellar bursa, the best treatment is to excise it. The incision for this operation should be made vertically on the outer side of the

bursa, curving inwards a little above the patella. If this incision is employed, the nerve supply of the skin in front of the patella, namely the patellar branch of the long saphenous nerve, is preserved.

Sometimes a bursa forms over the front of the tubercle of the tibia. It is called parson's knee, and should be treated on the same lines. Student's elbow is traumatic olecranon bursitis. Aspiration and pressure with strapping is the treatment. Sometimes the bursa between the ligamentum patellae and the head of the tibia becomes enlarged from injury. It causes pain on extension of the joint, because it is then pressed upon; and inability to get the leg quite straight. It forms a palpable and visible lump which bulges on each side of the ligamentum patellae. If aspiration does not suffice to cure it, the bursa should be excised.

A common bursa to become enlarged is that between the semimembranosus tendon and the inner head of the gastrocnemius. This condition is frequently seen in children when it is apparently due to injury. It is also seen in middle-aged people in association with osteoarthritis of the knee joint. The semimembranosus bursa does not communicate directly with the knee joint but it may connect with the bursa under the inner head of the gastrocnemius which itself communicates with the joint, so that it is not surprising that sometimes the fluid can be compressed into the knee joint; but many times the formation of fibrin blocks the communicating channel and renders this manœuvre impossible. Nothing beyond aspirating is ever necessary in the treatment of this bursa. Those in children always disappear eventually and, in the cases of adults with osteoarthritis of the knee joint, the condition remains stationary.

Other bursae which enlarge from injury are the bursa over the tuber ischii, the glutaeal bursa and the bursa underneath the sartorius at its insertion. It may prove necessary to excise any of these bursae if they become chronically inflamed with effusion.

Subacromial Bursitis deserves special mention. This is usually traumatic in origin and very often due to an injury at the insertion of the supraspinatus tendon into the greater tuberosity. In acute cases a swelling may actually be appreciable just below the acromion process where there is a point of tenderness. As a rule, the patient says there is less pain when the arm is hanging than when he is lying down. About 10° of abduction is possible at the shoulder joint but then the scapula moves. On continuing the abduction there is pain over an arc between 60° and 120°. Beyond this single movement becomes painless once more. In the more chronic stage the pain is often felt in the distribution of the circumflex nerve. There is a limitation of abduction which is due to adhesions between the roof and the floor of

the bursa. Sometimes the X-ray will show a calcification of the tendon of the supraspinatus.

In recent cases the patient should be given a sling and a pad in the axilla. Diathermy and heat hasten the absorption of inflammatory products and even the deposit of calcium. In persistent chronic acromial bursitis it is often necessary to remove the wall of the bursa, and particularly the calcified area in the supraspinatus tendon. The bursa is approached by an incision which splits the upper fibres of the deltoid muscle.

Pyogenic Bursitis.—Bursae, because they have lymphatics opening into them, are liable to become infected. Thus the prepatellar bursa may suppurate, either by direct extension from a septic focus in the overlying skin, from a penetrating injury or from a lymphatic infection, the organisms passing upwards from a suppurating focus on the foot.

The olecranon bursa is also liable to become infected in the same way. The signs of infection are fever, pain, redness of the overlying skin and great tenderness. If suppuration is suspected, a needle should be inserted into the bursa and the contents withdrawn. Penicillin is given. Great care should be taken not to open the bursa and drain it unless it contains thick pus and is consequently lined with granulation tissue. If it is opened before this it may refuse to heal and a persistent sinus exuding serous fluid remain. Rest on a splint and fomentations should be used both before and after incision.

Tuberculous Bursitis.—Chronic tuberculous bursitis is usually only seen in connection with tuberculous disease of joints and is not a separate entity.

Syphilitic Bursitis occasionally occurs and takes the form of a gummatous infiltration of the wall of the bursa. In the case of the prepatellar sac, a rather hard fibrous lump is formed and perhaps an ulcer with gummatous characters will develop. The condition is treated by giving anti-syphilitic remedies.

CHAPTER XLIV

FRACTURES AND DISLOCATIONS

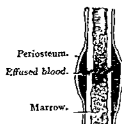
(I) Fractures

Fractures are classified as traumatic and pathological. When a normal bone is fractured by violence it is called a traumatic fracture, but when the bone has been weakened by disease and gives way before a slight injury the fracture is said to be pathological. Such disease of bone may be a primary sarcoma, a metastatic tumour, a simple bone cyst, an inflammatory disease like osteitis deformans, septic osteomyelitis, or a general disease such as fragilitas ossium. Fractures due to violence alone will be considered in this chapter.

When a long bone is fractured by the leverage action of a force applied to its extremities, it is said to be due to indirect violence. Under these circumstances the fracture is usually oblique or spiral in direction. Transverse fractures, however, also occur with indirect violence. When the bone gives way at the point of application of the force, the fracture is a direct one. A fracture is comminuted when the bone has been broken into several pieces. Sometimes a fracture is incomplete. In children the bones are soft like the living twig of a tree and they break in the same way; that is, when they are bent the convex side will break but the concave side will simply bend. Such fractures are called greenstick fractures. They are not seen in adults. In children also, the periosteum is comparatively much thicker than in adults, and it may not be torn when the underlying bone breaks. The result is called a subperiosteal fracture.



Greenstick fracture of radius and ulna.



Subperiosteal fracture.

When a fracture occurs there is often considerable damage to the muscles and connective tissue in the neighbourhood. The vessels in the Haversian canals and the marrow do

not retract as easily as arteries in other tissues because they have not so great a thickness of muscular tissue and therefore the bleeding is not so quickly stanched. The result is that a considerable haematoma takes place in the neighbourhood of the fracture. Sometimes the ends of the bone press upon the main artery of the limb, so interfering with the circulation, and occasionally the artery may be actually ruptured. In like manner injuries to nerves occur. The irritation of sensory nerves at the site of the injury causes reflex spasm of the surrounding muscles and this leads to overlapping of the bones and shortening of the limb. If the soft tissues are wounded there may be a direct communication between the external air and the raw surfaces of the bone and the fracture is said to be *compound*. *Fractures where the skin is intact are simple fractures.* This classification is very important as the outlook for the patient is very much more serious in compound fractures. Not only is there a great deal of effused blood in the neighbourhood of the broken bone ends, but there comes on, in addition, a swelling of the limb below the site of the fracture. This oedema is due partly to an obstruction to venous return caused by the effusion of blood under the deep fascia, partly to kinking of veins and lymphatics from the displacement occurring at the fracture, and partly to some of the efferent lymphatic vessels being torn across and so losing their function of draining the lymph away from the limb.

The Union of Fractures

The first bond of union between two surfaces of bone is the intricate network of fibrils of fibrin which form in the blood-clot. This network acts as a scaffolding along which connective tissue cells migrate from the periosteum, Haversian canals, cancellous spaces and from the marrow in the medullary cavity. They, together with capillary buds, form a mass of granulation tissue which covers over both extremities of the injured bone. The two layers of granulation tissue coalesce and form the cement, called callus, joining the two ends together. This callus is arbitrarily divided into three zones: (1) external callus, derived from the periosteum; (2) intermediate callus, derived from the spaces in the solid part of the bone; (3) internal callus, derived from the marrow.

In this granulation tissue osteoblasts put down layers of white fibres forming lamellae of osteoid tissue. Osteoid tissue is similar in structure to decalcified bone, that is, it contains osteoblasts and fibroid lamellae. In due course lime salts are deposited in it and it is changed into a rather open form of cancellous bone. At this

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stage callus can be felt as a hard mass of tissue joining the two ends. It is in its turn, under the influence of the strain placed upon the bone by use, partly absorbed and replaced, so that the bone assumes a more normal structure, but it is very seldom that the intramedullary plug disappears entirely. It can be easily realised that in order that such a delicate process may take place without disturbance there must be not only apposition of the bone ends, but immobility and an efficient blood-supply. Non-union may occur if these two factors are not present. (See page 565.)


Union of a fractured humerus.

The time for consolidation of a fracture varies very much. It depends upon the site of the fracture because in some situations a fracture will interfere very seriously with the vascular supply of one of the fragments; it will also depend on the circulation of the limb and the activity of the surrounding muscles, so that when, by active movements, the blood and lymph circulation is fostered, union is quicker than when there is immobilisation of those muscular structures. Union will also take longer if the limb is in such a position that oedema is allowed to occur. On the whole it may be said that no bone unites firmly under 6 weeks and, more often, 12 weeks or more are needed before there is complete consolidation. Of course, if there is severe constitutional disease the healing process may also be inhibited, or even prevented, from taking place.

Signs and Symptoms of Fractures

Sharp pain is felt at the time of fracture, pain that may be so great that there may be caused considerable shock. Thereafter the pain diminishes and remains less as long as the patient keeps the limb motionless, but with the slightest movement the pain is sharply intensified. There is usually complete loss of function of the limb. Objectively there is as a rule some alteration in the outline of the limb, an angulation where the part should be straight or a prominence in some abnormal situation; but sometimes, as in a subperiosteal fracture, no displacement takes place so that no deformity is evident. In such circumstances exquisite tenderness at the site of the fracture reveals its existence. Very soon after the fracture has occurred local swelling is seen and with it discoloration of the skin from the effused blood.

The swelling and oedema may become extreme. It soon spreads to the part of the limb distal to the fracture. By gentle manipulation it will be discovered that some movement takes place at a point where there is no joint. Whilst carrying out this test the grating of the hard, rough fractured surfaces together is sometimes felt and even heard. This characteristic grating, called crepitus, is absolutely diagnostic of a fracture; but as it is very painful for the patient, no effort should be made primarily to elicit it. When detected it should come as an incident in the very gentle search for abnormal mobility. All these signs are not invariably present in every fracture. Swelling, for instance, may be wanting in the subperiosteal fractures of children; and in an impacted fracture of the anatomical neck of the humerus, that is, a fracture in this situation in which the shaft has been driven into the head so that the two fragments are firmly fixed together, both abnormal mobility and crepitus will fail. The signs of fracture are then: (1) pain, (2) tenderness at the site of the break, (3) loss of function of the limb, (4) deformity in the outline of the limb, (5) abnormal mobility, (6) crepitus and (7) swelling with discoloration.

The Treatment of Fractures

Without making any serious attempt to correct displacement and remedy deformity, the immediate treatment should be to fix the limb in some temporary splint made of any serviceable article such as an umbrella or broomstick which may be handy. If movement of the part is prevented, much of the pain, and with it the shock, will disappear. The patient is then transported to his home or some perhaps more suitable place in order to set the fracture, that is, to bring the broken fragments into their proper anatomical position and to keep them so with some appliance. A radiograph in two planes at right angles must then be taken. We have seen how the distortion of the parts may cause obstruction to the venous and lymphatic return and how quickly swelling and oedema appear. It may be so great that after a few hours reduction of the deformity and the application of splints become very difficult. For this reason it has frequently been recommended to put the limb on a temporary splint, to maintain it in an elevated position, and to postpone the final setting of the fracture for a few days or a week until the swelling has somewhat subsided. Whilst from some points of view this has advantages, on the whole it is a plan not to be recommended. The longer a fracture is left the more difficult accurate reduction becomes. Also we have seen that the oedema and swelling are in large part due to the distortion of the

soft parts. So that reduction at the earliest opportunity has much to recommend it. In nearly every case the patient should have an anaesthetic. If a general one be chosen this should not be nitrous oxide gas, because muscular relaxation, which is essential, cannot always be ensured. In many cases also it is of advantage to have the duration of anaesthesia sufficiently long so that a skiagram may be taken and examined whilst the patient is still under its influence. An imperfect reduction can then be immediately corrected. For the lower limb a spinal anaesthetic is at times advisable, as when for instance the patient is a diabetic or bronchitic, and in the upper limb under like circumstances brachial anaesthesia may be used. Many surgeons now employ local anaesthesia. To effect this the needle of a syringe is plunged into the space between the broken ends where there is always a collection of blood, the aspiration of which will demonstrate that the space has been found. The syringe is now filled with 2 per cent novocain of which 20 c.c. are injected. This will stop pain, relax the muscles and cause shock to disappear. In very painful fractures a satisfactory X-ray examination cannot be made unless this has been done. The actual reduction of the fracture is done by manipulation. It has been mentioned how the muscles of a fractured limb go into strong spasm. Unless this can be overcome it is impossible to get the bones into place. On the contrary, if by pulling upon them they are stretched to their full length, the bones will often of themselves fall into their proper position, and if the traction on the muscles is still kept up, the tautness of them will maintain the correction. This maintenance has usually to be assisted by a splint of some kind. There are two methods in use for pulling upon the muscles. In the one a metal pin is put through either the lower fragment or through the bone below and traction is exerted upon this. It is called skeletal traction. In the other strapping is attached to the skin enveloping the muscles it is wished to stretch, and this is pulled upon. Traction on the skin will in its turn pull upon the deep fascia which in its turn will pull upon the muscles. This is called skin traction or strapping traction. Both methods have their uses. Not usually more than 10 or 15 lb. force can be applied to a strapping extension without its slipping, whereas as much as 30 or even 40 lb. can be used in skeletal traction, though such large forces are not often needed, and when they are it is usually for only a short period. Muscle spasm will give way before a much smaller force if it be a constant one. Over-extension of the limb with separation of the bone ends, if it is maintained for long, will cause very much delay in union.

A multitude of splints has been invented for the treatment of

fractures some of which will be described in the different sections which follow. Many of them are extremely efficient but very often their efficiency depends upon their fitting accurately, which means that a stock of them of different sizes, and often for the two sides of the body, must be kept. For this reason it is convenient to have at disposal splinting which can be adapted by the surgeon to any particular patient. Plaster of Paris and the splinting devised by Cramer conform to these requirements. The latter is depicted in the figure. It is made in different widths, it can be cut easily with a hack-saw, it is malleable and can be built up into splints with great ease. Plaster of Paris can be used in the form of muslin bandages in which the powder has been incorporated, or suitably shaped pieces of flannel, wrung out of water, can be soaked in a plaster cream made by mixing 5 parts, by volume, of the plaster with 3 parts of water. In most instances plaster of Paris is better put directly on to the ungreased skin without any underlying padding except of very prominent bony points. The advantage of such plasters is the perfect fitting and even pressure which is obtained whilst fixation of the plaster to the limb is brought about by the short hairs which are embedded in the plaster. As these hairs are said to be shed every three or four weeks, the removal of the plaster is not painful. After encasing a limb in a circular plaster splint, two unfavourable events may occur. If effusion continues to take place, the pressure under the splint may rise so high that the circulation is impeded and gangrene may actually occur. This is more likely to happen in the lower limb than in the upper, so that it is usually wise to split every encasing plaster of the lower limb at the time of its application. Signs of interference of the circulation are increasing pain, blueness and numbness of the fingers. There should be relief from pain when a fracture has been accurately reduced. If it does not disappear there is always something wrong: not necessarily interference with the circulation. The other event which may react unfavourably on the ultimate fate of the fracture is the subsidence of swelling underneath the fracture. Very often in a week after the plaster has been applied it will be seen that the casing is quite loose. The position of the fragments is sure to be disturbed underneath so that it is essential to remove the splint and apply a new one.


Cramer malleable wire splinting.

In order to get early firm union the fractured ends must be immovably fixed but the circulation through the limb should be kept as active as possible. This end is fostered by raising the limb to

facilitate the return of blood and lymph and by encouraging the patient to make any movement in the injured limb which does not disturb the fracture, for instance to move the fingers and shoulder joint, but not the wrist or elbow joints, in fractures of the forearm. When this is done the immobilised joints have little tendency to become stiff. The active movement of the muscles which pass over the seat of the fracture is immensely important in maintaining the nutrition of the limb and in assisting the repair of the damaged tissues. Massage is very inferior as an agent in assisting the circulation of lymph, and passive movements are very ineffective as a method of regaining the normal range. If they are carried out in the slightest degree too vigorously and cause pain, harm is done and the joints are likely to become stiffer. It is for this reason that the massage departments in some large clinics abroad have been abolished. But this would seem to be too extreme. A good masseuse is useful not for the massage she does but because she constantly urges the patient to try to perform movements which he otherwise would not do. She re-educates his muscles and brings him back to a normal outlook on his functional capacity. Patients should be encouraged to carry on every activity possible which their retentive apparatus will allow. In the lower limb, as soon as it is possible without risk of disturbing the position of the fragments, they are urged to walk in their splints. In this way the period of incapacity is very much reduced.

The Operative Treatment of Fractures

Under certain circumstances broken bones should be exposed and fixed together by some mechanical means. At one time the operative treatment of fractures of certain bones, such as that of the femur, was almost a routine. It is true that the accurate anatomical reposition of the fragments is one of the essentials for a perfect result, but experience has shown that it is possible to attain this end, as a rule, by closed methods of treatment. The open operation has certain drawbacks; it may be associated with a considerable degree of shock, it is often a long and tedious procedure and it is apt to cause stiffness in the muscles of the limb and to limit the movements of the neighbouring joints. An excellent result when seen by a skiagram has sometimes a very poor functional result. There are certain fractures, however, which must be treated by the open method, a prominent example being the transverse fracture of the patella for reasons which will be stated later. When a fracture opens into a joint it is of the utmost importance that the articular surfaces should be accurately apposed, for, if there is any unevenness, osteoarthritis is likely to

follow; but even when fractures invade the knee or elbow joints, it is often possible to get a very good result by non-operative measures. In fact if apposition can be obtained in this way there is less likelihood of adhesions forming in the joint. In the open treatment of fractures the mechanical fixation is sometimes effected by screwing a metal plate on to the side of the bone. In other cases, for example in an oblique fracture, the two ends may be encircled with a wire, or screws may be put through the bones. If metal is to be used as fixation material it should be vitallium alloy, because experimental work has clearly demonstrated that metals, as a rule, cause an inhibition of the reparative process, whereas vitallium metal seems to be quite inactive in this respect. Union of the fracture after open operation always takes longer than if a closed method has been employed, because the necessary exposure of the bone ends means further stripping-up of the periosteum and muscular attachments and so a further interference with the blood-supply; hence the plating of bones, as we shall see, is usually contra-indicated in the treatment of delayed union.

Some surgeons have recommended the fixation of fractures by a close-fitting intramedullary peg made of ivory, bone, deer antler or metal. This is a neat method of bringing about exact apposition but it is open to the very strong objection that the medullary material from which the callus is produced has to be reamed out of the bone in order to make way for the peg.

Open operation nowadays is only resorted to when closed methods have failed to produce alignment, or to restore the normal evenness to an articular surface, or when a fracture has been complicated with a nerve injury, or a dislocation of a joint and it is impossible to reduce the dislocation.

A graft from the patient's tibia applied to the external surface of the fractured bone and fixed with vitallium screws is a good method for ununited fractures. It stimulates bone-formation and can often be used with little further disturbance of the local blood-supply.

Complications of Fractures

Fractures may be complicated by infection, wounds of the soft parts rendering them compound, by injury to large arteries and nerves, by delay in the process of repair, and by such general conditions as shock, delirium tremens in drunkards, and hypostatic pneumonia in old people.

The Treatment of Compound Fractures

The treatment of compound fractures will, to some extent, depend upon the amount of damage which has been done to the soft parts.

If, as often happens, in a fracture of the leg the pointed extremity of the upper fragment of the tibia just penetrates the skin it may be sufficient to excise the skin edge under local anaesthesia, suture it and then treat the break as a simple fracture. But where there has been much laceration of tissue and contamination with dirt, very serious complications may arise. Tetanus, gas gangrene, osteomyelitis with pyaemia may all result. The prospect of escaping a serious infection is very much greater if the fracture is treated within 2 to 3 hours of injury.

The treatment of a compound fracture therefore must include that of contaminated or infected wounds as described in Chapter I. The patient should be anaesthetised as soon as possible. He may have a general anaesthetic, or a spinal anaesthetic, or brachial anaesthesia, or even have novocain injected locally all round the wound. When this has been done, the surrounding skin should be painted with iodine; or it may be washed with cetavlon. Contaminated and bruised edges of skin should be excised and, as far as possible, a slice taken off the whole surface of the wound. This clearly is not possible when the wound has gone down to large arteries and nerves, but where there is obvious visible dirt it must be taken off these structures even if it means removing a portion of the nerve sheath. When the bone itself has had dirt ground into it a shaving of the bone should be removed with a chisel. When haemostasis has been brought about and it is felt that all contaminated tissues have been excised, the wound, having been sprinkled with sulphathiazol and penicillin powder, may sometimes be sewn up and the fracture treated as a simple fracture; but it is impossible to remove the infection in this way if the limb is not operated upon within a few hours. If it is seen late and there is already infection present, then the whole wound should be left open lightly packed with vaseline gauze. In this case the best results will be obtained if the limb is encased in plaster of Paris. It is usually wiser to do this. In any case systemic penicillin is administered. In all grossly contaminated wounds the patient must receive a prophylactic dose of anti-tetanic and anti-gas gangrene serum. At the end of 5 days, if, after inspection, conditions appear favourable the wound is again sprinkled with penicillin-sulphathiazol powder and sutured. A new plaster splint is applied, or, in the case of the femur, a Thomas' splint combined with plaster may be more effective. Good immobilisation is necessary. In spite of the utmost care some compound fractures become heavily infected and, the patient's resistance being low, the inflammation may spread up the limb. In such an event the question of amputating to save life may well arise.

Interference with Union

It has been stated that the normal time for firm union of a fractured long bone is 6 to 12 weeks. Under certain circumstances there is very great delay in the process, which may fail completely to take place, so that we may have absolute non-union, delayed union or union by fibrous tissue.

When union absolutely fails, sometimes an adventitious capsule is formed between the bone ends and a false joint results. The term



Ununited fracture of humerus: false joint.



Ununited fracture of humerus.

"vicious union" is used for fractures which have joined with very great deformity. There are many alleged causes for delay in the cicatrisation of the bone: very poor general condition of the patient, serious illnesses, malnutrition, possibly syphilitic cachexia will delay the process, but the vast majority of cases of non-union are due to (1) the interposition of some tissue between the fragments which the osteoblasts cannot penetrate, (2) the non-apposition of the fractured ends, (3) excessive movement of the fragments on each other and, most important of all, (4) interference with the proper blood-supply of one, at least, of the fragments.

In the transverse fracture of the patella the periosteum may curl in between the surfaces and prevent union because the periosteum is a limiting membrane to ossification. If the bone ends are separated with a large piece of muscle intervening, again no union can take

place; this is not a very common cause of non-union if the fracture has been treated efficiently because traction will nearly always disengage the muscle and bring the fragments close together. Interference with the blood-supply of a bone is very difficult to deal with. If a fracture of the tibia takes place below the entrance of the large nutrient artery, the greater portion of the blood-supply to the lower fragments is cut off by the injury and the nutrition of this lower part of the tibia is maintained solely by vessels which pass into the bone from the surrounding periosteum. These vessels are not very numerous, and where there are no muscular attachments the deprivation of blood may be so great that repair is unable to occur in the proper manner. It is replaced by a slow sclerosis of the upper end of this lower fragment which is comparable with the formation of dense scar tissue in the soft parts. So hard does this layer of bone become that, when the collateral circulation is opened up and the blood-supply to the bone is improved, granulations find it impossible to penetrate this barrier and to initiate the formation of callus. If a specimen of such non-union is examined it will frequently be found that callus has been thrown out by the upper fragment and has formed a kind of cup round the atrophied, hard, sclerosed extremity of the lower fragment. There may be some actual union between the bones with fibrous tissue or a false joint may form. Certain bones are particularly liable to this disturbance of union; they are the tibia in its lower half, the radius, the shaft of the humerus and the scaphoid bone of the wrist joint.

The Treatment of Delayed Union

It is extremely important to recognise that good union may take place although the process may prove to be very slow; hence there should be no hurry to take active steps in remedying this defect of union. Every means of improving the circulation of the limb should be employed and the most important of these is to arrange some splint which will fix the bone ends immovably and yet allow the patient to use the limb. It is surprising how often, after a further two or three months, the fractured bone will become solid. A plaster of Paris bandage can usually be applied so that free play of muscles over the site of the fracture in the upper limb can take place. In the lower limb a walking plaster or a caliper splint is usually employed. Many of the older surgeons recognised the importance of improving the circulation at the region of the fracture in order to obtain union. Hugh Owen Thomas, the inventor of the splint, recommended the daily hammering at the site of the fracture of the leg with a soft mallet, the patient the whole time being allowed to go about in a

caliper splint. By this means after many months he was able to induce the bones to join. Other surgeons have injected irritants such as turpentine at the site of the fracture to induce an aseptic inflammatory reaction. If a fracture has not united by the end of nine months further steps should be taken. One of the most effective methods of inducing the bone to join is to drill a number of holes obliquely through the bone from the lateral surface a short distance from the site of fracture, through to the ununited cross-section; 10 or more holes are sometimes drilled. This makes channels through the sclerosed bone ends along which fibroblasts can migrate when granulations grow. Ossification across the gap will very often ensue. When this has been done and an interval of 7 months has occurred, and there is still no union, an open operation is indicated. In this operation every precaution should be taken to strip the bones as little as possible so as not to interfere with the blood-supply coming from the periosteum. Any fibrous tissue present between the bone ends must be excised and then the neighbouring sclerosed bone, which forms an impassable barrier, removed. This may be done either by an oblique saw-cut in each fragment or by the step method, illustrated in the neighbouring figure. In either case, when the fragments are brought together, there are broad surfaces of apposition composed of good vascular bone. They should be kept in contact by catgut sutures penetrating the bone or, perhaps, by wire or by screws. It is inadvisable to use plates for such immobilisation because plates cannot be applied without considerable interference with the local circulation of the bone ends. If this operation is done on the tibia, it will not be possible to bring the bones together unless the fibula is divided. Either a small piece is taken out of the fibula by a separate incision so as to allow the tibial fragments to come into contact, or the fibula is divided obliquely and the two portions allowed to slide on one another. The limb is then cased in plaster and, as soon as possible, the patient is fitted with a walking splint. The same procedures are applicable to fractures of the upper limb.


The principle of drilling the ends of the bone for non-union.


The step method of operating for non-union.


The principle of the inlay graft for non-union.

Another method is to effect a junction of the freshened bone ends

by an inlay graft in combination with a plate because, in bone-grafting, absolute immobilisation is essential. More often an onlay graft fixed with vitallium screws is used.

Recently a method of bone-grafting with cancellous bone has been introduced. It is called chip-grafting, and is particularly applicable where there has been a considerable loss of bone. It is therefore also useful in filling bone cavities and the gaps left where tumours have been removed. The cancellous bone is obtained from the ilium close to the crest. The compact bone on each aspect is split off, the intervening spongy tissue removed and cut into small pieces, a fraction of a centimetre in diameter. They are packed into the space it is required to fill, but they must be in contact with a freshly-cut bony surface from which osteoblasts can emigrate to invade their cancellous spaces. Porous bone of this kind is much more easily permeated by granulation tissue than the hard bone of an onlay graft. Here again, *absolute immobilisation by some means must be brought about.* Defects in the skull, and in the contours of the face due to fractures, have been successfully treated by chip-grafting. The fragments become welded together, smoothed out on the surface, and acquire a cortical compact layer.

Fat Embolism

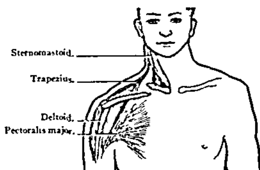
This is a condition in which emboli of fat lodge in the capillaries of the lungs, or in those of the systemic circulation, where those in the brain cause the predominating symptoms. It is usually a complication of a fracture, and is sometimes attributed to manipulation of the broken bones, but the evidence for this is not very convincing. It is supposed that droplets of fat get forced into the veins of the marrow and so reach the heart and are conveyed to the lungs. Another idea is that the fine emulsion of fat in the plasma is caused to become a coarse one by aggregation of its particles under the influence of some poison in the blood. Ether injected into the veins or administered by inhalation in dogs has been shown to do this, so there is just a possibility that ether may be responsible for some cases in man. The accident occurs about the fourth day after the fracture. There are two types of fat embolism. In the respiratory type there are cyanosis, breathlessness and cough; moist sounds are heard in the lungs and sometimes there is rusty sputum. In the cerebral type the fat has got through the capillaries of the lungs and reached the systemic circulation. Fine emboli occur throughout the brain. At first there is delirium with a rise of temperature; later this passes into a coma

with convulsions and paralysis. Patients usually recover from the pulmonary type, but succumb to the cerebral form of the disease.

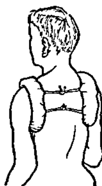
Fractures of the Upper Limb

Fractures of the Clavicle

The clavicle is broken by falls on the point of the shoulder or on the outstretched arm, very rarely from direct violence. The commonest situation of a fracture is in the middle third and here there is the typical displacement. The inner fragment is drawn upwards by the sternomastoid, whilst the outer fragment is pulled downwards and forwards by the weight of the arm. The patient experiences a great deal of pain and, as the upper limb is quite helpless, he usually supports the elbow on the injured side by the opposite hand. Diagnosis is made simply by palpation. In order to bring the two fragments into their proper line, the shoulder must be raised and braced backwards. This is brought about most effectively by padded rings which are drawn over the two arms and encircle the axilla and point of the shoulder. The rings should be of a size suitable for the particular patient, and they are provided with two tapes on each side behind. By tying these tapes together the shoulders are braced back. The point of the shoulder is kept raised by a properly adjusted sling supporting the elbow. This is a very comfortable appliance, the great advantage being that movements of the fingers and forearm can be carried out from the first. In children a greenstick fracture of this region is very common. There is nothing but a lump to be felt in the middle of the clavicle with perhaps some staining of the tissues with blood. The child can perform all his movements without pain. A sling alone is necessary for treatment except that, in young children, the arm should be at the same time bandaged to the side. Fractures also occur at the inner end of the clavicle and at the outer extremity; they can be



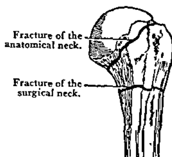
Displacement in fracture of middle third of clavicle.


Padded rings for fractured clavicle. The affected arm must be supported in a sling.

treated in the same way. It is very seldom that pressure on arteries and nerves occurs with a fractured clavicle, and very seldom that an open operation is necessary.

Fractures of the Upper Extremity of the Humerus

The commonest fractures which occur here are fractures of the anatomical neck, fractures of the greater tuberosity and fractures of the surgical neck; that is, the part of the bone between the anatomical neck and the upper limit of the insertion of the pectoralis major. In children separation of the upper epiphysis of the humerus, which includes that of the greater tuberosity, also happens.

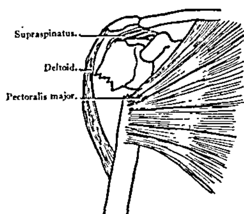


Fractures at the upper end of the humerus.

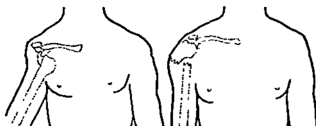
Fractures of the Anatomical Neck occur in old people; they are very likely to be impacted and they are quite easily overlooked because there is no disturbance in the position of any bony point, but the extreme disability, the pain and the extensive extravasation of blood in the neighbourhood are all signs of some serious injury, which the X-ray examination will reveal to be a fracture in this situation. There is not usually serious displacement, so that the only treatment required is a pad in the axilla, a sling to support the arm and an encircling bandage to keep the limb to the side.

Fracture of the Greater Tuberosity.—This fracture is not very disabling provided there is not much displacement. It can be easily treated by fixation of the arm in a sling. It assumes serious importance if it is associated with a dislocation of the shoulder joint, and it is also of some importance if there is much separation. In the latter case the fracture should be treated in a splint which holds the arm at right angles to the body. There are many splints of this pattern made of light material. If the fracture of the greater tuberosity accompanies an anterior dislocation of the shoulder joint, it may be the cause of recurrent dislocation, because the strong subscapularis and pectoral muscles are unbalanced by those attached to the greater tuberosity and tend to pull the humerus forwards again out of contact with the glenoid cavity. Under such circumstances it is sometimes wise to expose the greater tuberosity through a vertical incision, which splits the fibres of the deltoid, and to fix it on to the shaft with a screw or bone peg, as it is not a good plan to treat a reduced dislocation of the shoulder in an abducted position.

Fracture of the Surgical Neck.—This is a common fracture of adult life and quite commonly also it is an impacted fracture. When, however, there is complete separation of the bone fragments, two types of displacement are seen. In one the upper fragment is abducted by the supraspinatus and externally rotated by the other muscles attached to the greater tuberosity. The upper end of the lower fragment is dragged inwards by the pectorals and other muscles and the whole bone pulled upwards by the triceps and biceps. In the second type the lower fragment may be dragged in towards the chest wall, but the upper fragment remains more or less vertical. There is great swelling in the region of the shoulder joint and upper arm with discoloration of the skin. There is a typical outline to the shoulder, an abnormal prominence appearing just below the acromion and a depression beneath this. Reduction is carried out by pulling on the arm at right angles to the body. If the muscles have been relaxed by local or general anaesthesia it is usually possible to overcome the spasm and cause disappearance of the overlapping. The two ends can then



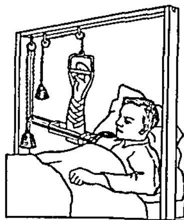
Muscles causing displacement in fracture of the surgical neck of the humerus. The latissimus dorsi and teres major also help to pull the lower fragment medially, whilst the biceps and triceps both pull it upwards.


The change of outline of the shoulder produced by a dislocation of the shoulder and a fracture of the surgical neck of the humerus.

be brought into apposition and the jagged surfaces will frequently interlock. This manœuvre is not always successful and that advised by Frankau should be tried. The arm is dragged over to the opposite side of the body on the front of the chest, when the fragments will disengage and the two ends are at an acute angle pointing towards the same direction. The humerus should be rotated externally so that the hand points forwards and the arm slowly levered into a

direct line with the upper fragment. As in all fractures, reduction should be confirmed by a skiagram. There is some difference of opinion as to how this fracture should be treated subsequently to reduction. Many surgeons believe that the arm should be kept in a position at right angles to the body with the hand pointing forwards and maintained in this position until union is formed, a question of 4 or 5 weeks. This is recommended because, if the shoulder joint should become stiff, it is far easier to regain adduction in which gravity will help during the whole of the day than it is to regain abduction should the shoulder joint become stiff with the arm at the side. The objection to this line of treatment is the very serious difficulty in splinting the arm in this position. A multitude of supports has been invented but none is really effective, and if such a splint is not kept firmly up in the axilla on the injured side, if it sags, it will not only produce pain but cause displacement of the fractured bone ends. Therefore, ambulatory treatment in an abduction splint is not recommended for this fracture. When reduction has been brought about, it more often than not happens that the arm can be brought to the side and the bones will remain in alignment. When this is the case a pad should be placed in the axilla, a sling used to support the elbow and an encircling bandage round the chest and upper arm be applied. It is true the shoulder joint is maintained in a position of adduction, but stiffness can be guarded against, and in very many cases prevented, by insisting that the patient should perform some movement from the very beginning of treatment. He should use his fingers and hand muscles; he should flex and extend the elbow joint through a few degrees and he should be made to shrug the shoulder on the fractured side. All these actions help the circulation and the stagnation of lymph and maintain the tone of the muscles which pass over the site of the fracture and prevent adhesion of muscles to the capsule of the shoulder joint. Very soon the range of movements can be increased. Passive movements should never be carried out as they will probably lead to displacement of the bone ends and are very ineffective. This line of treatment is also indicated in fractures of the anatomical neck of the humerus. In those patients in whom the upper fragment remains persistently abducted when an attempt is made to bring the arm to the side, treatment must be carried out in the abducted position. How much the arm should be abducted from the side will depend upon the angle the upper fragment makes. These patients should be treated in bed. A splint similar to a Thomas' knee splint supports the arm; traction is applied by strapping which must extend up to and as far as the axillary fold and, either by this strapping or by a wire through the olecranon, the pull is taken to the end of the

splint, where it is fixed; or over a pulley attached to the end of the splint when a weight is used. The forearm is kept at right angles to the arm and, by strapping, is suspended to an overhead beam. The method of putting up this structure is seen in the annexed figure. So that the rule for treating a fracture of the surgical neck is that, when alignment is maintained with the arm at the side, the patient may be up and about, but when abduction is necessary for alignment the patient should be treated in bed. Union of a fractured surgical neck will take 4 or 5 weeks to become firm and retentive measures should be adopted for this period, after which gradually increasing active exercises are all that is necessary.

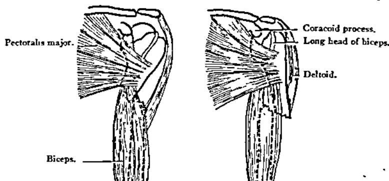


Traction in abduction for a fracture of the humerus.

Separation of the Upper Epiphysis of the Humerus.—This is an injury of children which takes the place of the fracture of the surgical neck in adults. Clinically the condition of affairs is rather like an anterior dislocation of the shoulder joint because the upper end of the shaft comes forwards into a position just outside the coracoid process; *but dislocation of the shoulder does not occur in children and by* careful palpation it is possible to feel the greater tuberosity just underneath the acromion process. Reduction is carried out by pulling on the arm at right angles to the body after which the arm is bandaged to the side over a sling.

Fracture of the Shaft of the Humerus

Fracture of the shaft of the humerus may take place by direct



Displacement of the fragments when the humeral shaft is broken above or below the insertion of the deltoid.

violence, but much more commonly by indirect violence. It has even occurred by the throwing of a cricket ball. The fracture may be

direct line with the upper fragment. As in all fractures, reduction should be confirmed by a skiagram. There is some difference of opinion as to how this fracture should be treated subsequently to reduction. Many surgeons believe that the arm should be kept in a position at right angles to the body with the hand pointing forwards and maintained in this position until union is formed, a question of 4 or 5 weeks. This is recommended because, if the shoulder joint should become stiff, it is far easier to regain adduction in which gravity will help during the whole of the day than it is to regain abduction should the shoulder joint become stiff with the arm at the side. The objection to this line of treatment is the very serious difficulty in splinting the arm in this position. A multitude of supports has been invented but none is really effective, and if such a splint is not kept firmly up in the axilla on the injured side, if it sags, it will not only produce pain but cause displacement of the fractured bone ends. Therefore, ambulatory treatment in an abduction splint is not recommended for this fracture. When reduction has been brought about, it more often than not happens that the arm can be brought to the side and the bones will remain in alignment. When this is the case a pad should be placed in the axilla, a sling used to support the elbow and an encircling bandage round the chest and upper arm be applied. It is true the shoulder joint is maintained in a position of adduction, but stiffness can be guarded against, and in very many cases prevented, by insisting that the patient should perform some movement from the very beginning of treatment. He should use his fingers and hand muscles; he should flex and extend the elbow joint through a few degrees and he should be made to shrug the shoulder on the fractured side. All these actions help the circulation and the stagnation of lymph and maintain the tone of the muscles which pass over the site of the fracture and prevent adhesion of muscles to the capsule of the shoulder joint. Very soon the range of movements can be increased. Passive movements should never be carried out as they will probably lead to displacement of the bone ends and are very ineffective. This line of treatment is also indicated in fractures of the anatomical neck of the humerus. In those patients in whom the upper fragment remains persistently abducted when an attempt is made to bring the arm to the side, treatment must be carried out in the abducted position. How much the arm should be abducted from the side will depend upon the angle the upper fragment makes. These patients should be treated in bed. A splint similar to a Thomas' knee splint supports the arm; traction is applied by strapping which must extend up to and as far as the axillary fold and, either by this strapping or by a wire through the olecranon, the pull is taken to the end of the

put over the internal condyle and the external condyle to avoid pressure and the plaster should be moulded to the arm and fixed, whilst wet, with a muslin bandage. When dry it is covered with an ordinary bandage and, except for a sling to support the wrist, this is all that is necessary. Sometimes a plaster of Paris spica is more effective. If, however, there is much overlapping and the fragments will not come into apposition, some method of traction must be used. The patient may either be treated in bed as described in fractures of the surgical neck, and this is in many ways the better course, or he may be treated as an ambulatory patient by a traction splint which takes its purchase in the axilla. Union will take 5 to 6 weeks and the arm must be maintained in the splint all this time.

Fracture of the middle of the shaft of the humerus is one of those fractures where non-union is apt to occur, so the immobilisation may have to be very prolonged. In injuries of the musculospiral nerve it is usually the best policy to reduce the fracture and keep it in the best possible position. In a few weeks' time signs of recovery of function are almost certain to occur. Weakness of the musculospiral nerve which comes on as a late feature, is due to the pressure of callus. Under these circumstances the nerve must be exposed by a vertical incision down the back of the arm, the projecting callus chiselled away and a flap of triceps muscle interposed between the nerve and the bone.

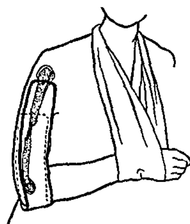
Fractures of the Lower End of the Humerus

The fractures which occur here are the transverse supracondylar fractures of adults, the T- and Y-shaped fractures in which there is in addition a break going down into the elbow joint, fractures of one or other condyle, separation of the medial epicondyle and the so-called separation of the lower epiphysis of the humerus in children, which is the commonest of all these injuries. In this last the line of fracture lies immediately above the epiphyseal junction and runs upwards and backwards. There is a posterior displacement of the lower fragment; much less commonly the fractured surface of the lower fragment looks upwards and backwards and the displacement is forwards. In the usual case there soon appears very great swelling of the parts so that it is difficult to make out any landmarks in the neighbourhood, but they can usually be detected by carefully massaging away the oedema over the situation of such bony points with the aid of a little talcum powder. The general appearance of the elbow can be seen in the figure. The three bony landmarks, namely the medial and lateral epicondyles and the tip of the olecranon process, remain in their proper positions relatively to each other, but if one

transverse, oblique or spiral. If it is above the insertion of the deltoid muscle, the upper fragment is pulled inwards by the powerful muscles connecting the chest with that part of the bone (pectoralis, latissimus dorsi, teres major), whilst the lower fragment is tilted outwards by the deltoid and pulled upwards by this muscle, the triceps and the biceps. If the fracture is below the insertion of the deltoid the lower fragment tends to be pulled up to the inner side of the upper one. As the fracture takes place in the vicinity of the musculospiral nerve, tests should always be carried out to discover whether any injury to this structure has taken place. The most prominent clinical features of fractured humerus are the absolute helplessness of the arm and the angulation which takes place when an attempt is made to lift the arm from the side by patient or surgeon. Reduction can be brought about by traction after anaesthetisation. If the bones come into apposition and remain in place, as they sometimes do with transverse fractures, it is sufficient to apply a long plaster slab which runs down the outer



Pressure on the radial nerve in fracture of shaft of humerus.



Plaster slab on medial and lateral aspects of the arm with support for wrist in fracture of shaft of humerus.



Plaster spica for shoulder, useful for fractures of the upper end and shaft of humerus. Note the strut of Cramer splinting.

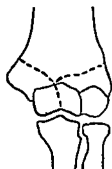
side of the arm from just beneath the acromion process to the elbow joint, underneath the olecranon with the elbow bent to right angles, and up the inner side of the arm nearly to the axilla. Pads should be

tained by these measures and under these circumstances the patient is anaesthetised and traction is made on the forearm and, whilst reduction is maintained, a plaster strip is applied to the humerus in the manner described under the treatment of fracture of the shaft. It is carefully moulded over the top of the condyles and fixed with a muslin bandage. Another plaster bandage is then applied in a circular fashion to the arm and forearm as far as the wrist. If necessary, the patient is kept in bed and the whole plaster pulled upon by a weight running over a pulley attached to strips of adhesive plaster, which are applied to the outer surface of the plaster of Paris in the line of the humerus. In ordinary fractures immobilisation need only be maintained for one month but, during this time, the child should be encouraged to use its fingers and shoulder joint. When the splint or sling has been removed no further treatment is required in children under 12 or 14 years of age. There will be little or no movement to begin with owing to the fact that callus projecting at the site of the fracture will get in the way of the olecranon behind and the coracoid process in front. If massage and passive movements are instituted at this stage, there will be increased ossification and more stiffness will result, but, if the limb be left for the child gradually to bring into use by itself, a complete range of movement of the elbow joint will return in about a year. This is due partly to absorption of callus but more to the fact that the line of fracture lies above the epiphyseal line and, hence, with the increase in the growth of the bone the obstructing callus is pushed away up the shaft and no longer remains a hindrance. This action does not come into play, however, when the child is nearly fully grown and no increase in the length of the humerus is to be expected.

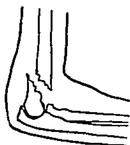
The supracondylar fracture of adults is very much less common than in children but can be treated in the same way. Here, however, after removal of the retentive apparatus the patient should be encouraged to carry out active movements as soon as possible. He is more likely to get back his function if, during the time of immobilisation, he has contracted the muscles which run over the joint.

T- and Y-shaped fractures present another very serious problem and many surgeons consider that they should be treated by an open operation in order to restore exactly the contour of the outline and articular surfaces. The Y-shaped fracture appears to result from the wedge-shaped upper surface of the coronoid process being forced against the trochlear surface of the humerus, splitting the bone at this point. The fracture line runs from the outer part of the trochlear surface upwards into the shaft and then bifurcates, reaching the mesial and lateral surfaces above the condyles. As great force

or other supracondylar ridge is traced downwards, it will be found to lead to a point in front of the corresponding epicondyle, thus demonstrating the backward displacement; at the same time the lower extremity of the shaft forms a projection in front. When there is anterior displacement this condition of affairs is reversed and the sharp lower extremity of the upper fragment can be felt under the skin at the back of the joint. The elbow is held in a position of three-quarters extension. It is impossible to bring about flexion until the deformity has been reduced. This should be done as soon as possible or increasing oedema will make it extremely difficult to maintain any reduction which has been achieved. Under anaesthesia the elbow is brought to a right angle; traction is made on the forearm with the arm abducted and the lower fragment pushed forwards from behind. There may be some lateral displacement which will have to be corrected at the same time. When the bone is in position the elbow should be flexed to such a degree that the triceps is pulled with some tension over the back of the fracture and keeps the fragments in position.

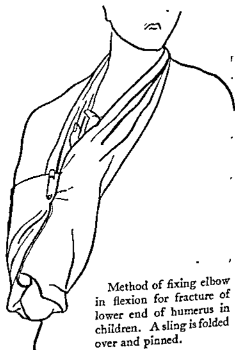


Line of Y fracture of lower end of humerus.



Supracondylar fracture of humerus.

There is no need to supinate the forearm; it will naturally go into a position of pronation and should be left like this. A sling is then applied in the usual way and the two sides overlapped as shown in the illustration. There is a certain danger in employing this simple method of treatment unless great care is taken to ensure that flexion is not carried to that degree which interferes with the circulation of the limb. This will be rendered very evident by oedema and swelling of the hand and great pain. Unless it is relieved very quickly Volkmann's ischaemic myositis will result. But this should not be an excuse for abandoning such a very simple and effective manner of treatment. In certain cases reduction of the fracture cannot be main-



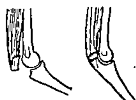
Method of fixing elbow in flexion for fracture of lower end of humerus in children. A sling is folded over and pinned.

to the pressure of bone or callus when the fracture extends to the medial side of the bone. Then there is the late ulnar paralysis which comes on after a fracture of the lateral condyle. If, in a fracture of the lateral condyle, the growth is interfered with, the normal carrying angle of the elbow joint is changed into a distinct cubitus valgus. This stretches the ulnar nerve over the increased angle and leads to weakness of the muscles supplied by it. Both these lesions are treated by transposition of the ulnar nerve from the back of the medial condyle to the front. The new path is shorter so the nerve is relaxed.

Fractures of the Forearm

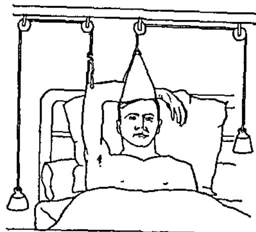
Fracture of the Olecranon Process

Fracture of the olecranon comes from falls on the point of the elbow. The process is usually broken transversely either near its tip or near its base. The amount of separation which occurs between the fragments varies considerably and depends upon the degree of associated damage to the triceps tendon, for this tendon sends prolongations down each side of the olecranon process strengthening the periosteum in this situation. If this expansion is torn, then wide separation takes place by the powerful traction of the triceps muscle. The prolongation gets thinner as it proceeds downwards and therefore it is more likely to be torn right across when the fracture is at the base of the olecranon; hence it is much more usual to find a wide gap in fractures of the base than it is in fractures of the tip of the process. The results are a helplessness of the arm and very considerable swelling, which is due to bleeding into the elbow joint. There is much extravasation visible. If the posterior border of the ulna is traced upwards, the gap of the fracture will be easily perceptible. If there is no separation at all, the arm should be fixed in a plaster bandage and the elbow can be kept at a right angle but, in every case where there is distraction of the fragments, an open operation should be performed to reconstitute the smooth articular surface of the sigmoid notch and to restore power to the triceps. The fracture site having been exposed by a horse-shoe flap and blood removed from the joint, the fragments are placed together and maintained there by a stainless steel wire, which may be passed either transversely or vertically across the gap. The method of fixing the separated piece of bone by



On the left the olecranon is fractured below the triceps expansion; much separation. On the right the fracture near the tip is kept in position by the triceps insertion.

is required to produce this fracture, displacement may be great. The two loose fragments are not only thrust backwards but widely *separated.* Although exact reposition of the fragments can be brought about by an open operation by *nailing the fragments to the shaft,* yet, on the whole, it must be admitted that end-results, as far as function is concerned, are better by a closed method of treatment. *The patient must be in bed and* he should have traction carried out by a wire passed through the olecranon process. His arm is best treated in the vertical position, *the forearm horizontal across the* body under the influence of traction. The two fragments are brought down into position by traction when they can be forced together by pressure with the hands. A plaster bandage round the arm moulded over the condyles, which must be padded for protection, will maintain the reduction. The results of the closed method would appear to be better because there is no further separation of *periosteum and no further damage to muscles, such as must* occur with the open operation. If the patient is encouraged to move his fingers and wrist while his arm is in a splint, he may regain complete range of movements ultimately. When one condyle only is split off the same measures may be employed and equally good results obtained.



Method of traction for Y-fracture of lower end of humerus. Ensheathing in plaster of Paris is sometimes also necessary.

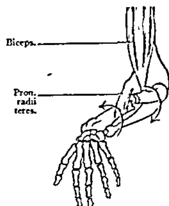
Another injury is the separation of the medial epicondyle of the humerus. It may be dragged off by muscular traction and the medial lateral ligament at the same time torn and the fragment *forced between the bones. The only way to* treat this satisfactorily is to make an incision running downwards and forwards over the flexor group of muscles, to pull the fragment out of *the joint cavity and suture it again into position.*



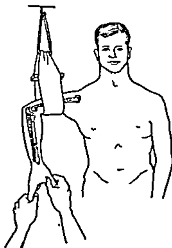
Cubitus valgus after a fracture of the lateral condyle causing a stretching of the ulnar nerve.

Fractures of this extremity of the humerus are sometimes associated with nerve injuries; quite rarely the median nerve suffers from pressure in front *by the extremity of the upper fragment*; quite rarely also the musculospiral nerve is damaged; much more commonly occurs an injury of the ulnar nerve. This ulnar paralysis is of two varieties; there is the early paralysis which is due

in the position midway between pronation and supination and union occurs, all supination beyond this will be lost, so that, in such fractures, the forearm must be kept in a position of extreme supination until union has taken place. On the other hand, if the break is below the insertion of the pronator teres, the upper fragment will assume the mid position and it is in this position that the forearm should be kept. The fixation apparatus should extend from well up the arm to the heads of the metacarpal bones; otherwise it may not get a good purchase on the fractured bones. In order to reduce these fractures the patient is laid on a table or bed with the head pointing to a wall or other fixed object to which, by means of a hook, a sling can be fixed which pulls on the upper arm extended at right angles to the body. In order to prevent compression of the soft tissues and interference with the circulation by this countertracting sling, the sides of it are separated by a wooden stirrup on the cephalic side. Traction on the forearm is carried out by an assistant who is able to get a firm hold of the thumb and outer three fingers by painting these digits with mastisol and covering them with gauze. He should maintain continuous traction for 3 or 5 minutes with the arm in either extreme supination or the mid position, according to the situation of the fracture of the radius. If the anaesthetisation is effective and the traction is continuous, bone ends will almost certainly go into line. Whilst traction is kept up, a plaster slab on the extensor surface of the arm and forearm is carried from above the insertion of the deltoid to the heads of the metacarpals and fixed with a muslin bandage. Another plaster slab is applied to the anterior aspect of the forearm below the elbow to the same level distally. This is also fixed by a muslin bandage. When these two plasters have become set, traction may be relaxed so that a circular plaster bandage may encase the whole of the arm and forearm to the knuckles.



Supination of the upper fragment and pronation of the lower, when the fracture is above the insertion of the pronator radii teres.


Method of reduction of a fractured forearm and the maintenance of the position whilst plaster of Paris is being applied. The patient is recumbent.

inserting a screw from the end of the olecranon down into the shaft is not very satisfactory, because sometimes the screw cannot get a good purchase here. When an open operation has been performed there is no need for prolonged immobilisation, and gentle active movements should be begun as soon as the stitches are removed.

Fractures of the Upper End of the Radius

Fracture of the neck of the radius is a fairly common result from falls on the hand. The head of the radius is broken off transversely just beneath the articular surface and the shaft is driven up into it, becoming impacted there. Or, sometimes, the head remains loose and displaced, or again, a portion of the head alone may be broken off, usually the anterior part.

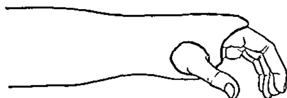
When there is simple impaction without displacement, the arm should be put up in the acutely flexed position and maintained in this position by means of a sling as in the separated lower epiphysis of the humerus in children (page 576). If the head has been displaced or a fragment is broken off and is loose in the joint, open operation to remove the fragment is required or great disability will result. The incision to remove the head of the radius is made from the back of the lateral condyle downwards and inwards along the upper border of the supinator brevis and through the anconeus muscle. The joint is very superficial here and the separated fragment can be quickly removed.

Fractures of the Shafts of the Forearm Bones

Either the radius or the ulna may be fractured separately or both may be broken together. These injuries usually result from falls on the hand but the ulna may be broken by direct violence as in warding off a blow.

Fractures of both Shafts.—Fracture of both bones of the forearm sometimes proves to be one of the most troublesome of all fractures to treat. Union is apt to take place with a certain amount of angulation, for, with the limb supported in a sling, the forearm will sag at the site of the fracture unless great care is taken. Again, sometimes the four fractured ends will be fused into a mass of callus across the interosseous space; this will prevent all movements of rotation. Then, if the fracture of the radius is above the insertion of the pronator teres, the upper fragment will be strongly supinated by the biceps and supinator brevis, whilst the lower fragment will be pronated by the pronator teres and pronator quadratus. If such a fracture is put up

the ulna, because the medial ligament of the wrist joint is either torn or there is a separation of the styloid process of the ulna. The fracture is often impacted. Considerable disability results unless there is accurate reposition of the broken bone. A tenosynovitis in the front of the wrist is very likely to be set up, causing a weakness of action of the flexor muscles and considerable pain. After anaesthetising the part, or the patient, reduction is brought about by forcible disimpaction of the two fragments. This is done by the surgeon pressing hard with the scaphoid of his wrist on the lower end of the upper fragment in front and with the other hand on the lower fragment behind, while, by rotatory force, the bones are separated and brought into position. In this manœuvre the patient's wrist is pronated and the surgeon should employ his right hand for pressing on the posterior aspect when the left bone is fractured, his own left hand pressing upon the upper fragment in front. The position of the hands is reversed for fracture on the right side. Very great force is at the disposal of the surgeon by employing this method. Another way to reduce the fracture is to grasp the hand as though in a handshake, and, by pulling on it, to cause disimpaction. At the same time ulnar deviation will bring the bones into their proper position. This method is not as good as the former because it is liable to increase the damage to the ulnar collateral ligament. Reduction is complete when the styloid processes are restored to their proper levels and the prominence has disappeared at the back of the wrist. There is some difference of opinion as to which is the best way to splint these fractures. Generally, it may be said that the best position is to have the metacarpal bones directly in line with the bones of the forearm; that is, there must not be flexion or extension at the wrist joint. The old-fashioned Carr's splint, although it has been discarded by most surgeons, in suitable cases is a very efficient instrument for maintaining the restored position of the wrist. It should always be used with the dorsal splint. A better method for general use, however, is to apply a plaster of Paris slab on the back of the forearm and wrist reaching from the heads of the metacarpals to the upper third of the forearm. This is all that is necessary. It is essential that the patients should move the fingers and thumb from the first; in this way stiffness will be prevented. The splint should be worn for 3 weeks. Some surgeons



Plaster of Paris splint for Colles' fracture, showing position of wrist joint and the freedom of the fingers and thumb.

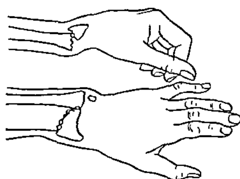
Reposition and accuracy of the reduction is checked by X-ray. Most fractures of the forearm can be treated effectively by this simple method, but in those where two such attempts fail to reconstitute the forearm it is necessary to transfix the olecranon with a wire, and the radius and ulna about three fingers' breadth above the wrist joint by another wire, and to maintain traction on these wires whilst a plaster bandage is applied. The wires are included in the plaster casing and thereby maintain the reduction.

It must be admitted, however, that in quite a considerable number of these fractures it is impossible to maintain reduction by external splints. In such cases one of the bones, usually the radius, should be plated by open operation. It is not usually necessary to plate both bones.

Union is sometimes very slow in the case of the forearm and there is not likely to be firm union under 5 or 6 weeks during which time the plaster should be maintained but, throughout all this period, movements of the shoulder joint and of the fingers must be carried out. Volkmann's ischaemic paralysis also is sometimes a complication of fractures of the forearm as well as fractures of the lower end of the humerus.

Colles' Fracture

This fracture is due to falls on the outstretched hand, the line of separation being about a finger's breadth above the lower articular surface of the radius. There is a triple displacement of the lower fragment; the hand is rotated backwards round a coronal axis, laterally round a sagittal axis and the lower fragment is displaced, as a whole, backwards, so that a very characteristic deformity is produced; from the side view it has been likened to the shape of a dinner fork. There is radial deviation of the hand. A projection made by the lower end of the upper fragment of the radius can be felt in front, and the projection of the lower fragment behind. Owing to the lateral rotation, the styloid process of the radius, instead of being at a lower level than that of the ulna, is either on the same level or raised above it. There are two tender areas: on the dorsum of the wrist along the line of fracture and over the styloid process of

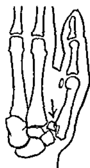


Colles' fracture showing the dinner fork deformity above and the radial deviation of the hand below.

to have the wrist in slight dorsiflexion. Movements of the fingers and thumb should be carried out from the first. *Two nutrient arteries* enter the scaphoid bone, one at the tuberosity and one at the waist of the bone. Sometimes a fracture going through the bone will leave the ulnar side of the scaphoid without any blood-supply, both the nutrient arteries entering the radial fragment; or sometimes the fracture will tear and thrombose the nutrient artery going into the body of the bone. This is the cause of very delayed union and necessitates prolonged immobilisation. Unless this is done there will be permanent non-union and great disability. It has been the practice in some clinics to remove the ulnar part of the scaphoid, but this operation always leaves some weakness behind it and is not to be recommended. In such cases the union can be brought about by drilling the fragments, as described on page 567. After this drilling has been performed it may be necessary to fix the wrist for as long as 3 months. When the fracture fails to unite after prolonged treatment, better results are obtained by removing the whole of the bone than just the one fragment.

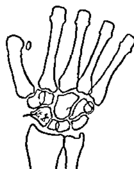
Fractures of the Metacarpal Bones

A common fracture of the first metacarpal bone is one where the line of separation runs downwards and backwards from just above the base of the bone; a triangular fragment is thus broken off, the upper extremity of the bone allowing the shaft to be displaced backwards. This is called a Bennett's fracture. Reduction is very easily brought about by manipulation, but there is a very great tendency to re-displacement so that there is sometimes much difficulty in getting a good anatomical result. Yet, unless this is obtained, there is very considerable disability, as the movements of abduction and adduction at the metacarpo-carpal joint of the thumb are seriously interfered with. A plaster of Paris splint should be made which encases the lower two-thirds of the forearm, extends along the dorsum of the hand to the heads of the metacarpals, encloses the thenar eminence and extends along the whole length of the thumb. Whilst traction is applied to the thumb, the splint is moulded in the region of the anatomical snuff-box to keep the base of the bone in place: sometimes this is not sufficient as re-displacement occurs directly the traction is released. Under such circumstances traction by strapping should be applied to the thumb, and maintained by


Bennett's fracture of the first metacarpal.

recommend putting *the wrist in a flexed position*, others in a position of dorsiflexion: the latter position is scarcely ever right as it tends to cause re-displacement of the fracture. It is true that in flexion the extensor tendons stretched over the back of the fracture will help to maintain the reduction but this is offset by the likelihood of the wrist joint becoming stiff and the range of dorsiflexion permanently limited. The flexed position is required only in those cases in which the bones have been allowed to unite with a persisting deformity and in which this deformity has been broken down by an open operation. This remaking of the fracture, when it becomes necessary, is best performed through an incision on the dorsum of the wrist, which lies between the extensor indicis and the extensor secundi internodii pollicis. After the bone has been divided and the wound closed, the wrist should be fixed in plaster in the flexed position for a week or 10 days.

Separation of the Lower Epiphysis of the Radius.—This accident only occurs in young people and, at first sight, it resembles a Colles' fracture. *The difference is that the displacement is a simple movement* backwards of the epiphysis so that there is no alteration in the levels of the styloid processes. Another factor which is of importance is *that after reduction there is a considerable tendency for the epiphysis* to become re-displaced. In these injuries it is advisable to fix the wrist in plaster in the flexed position. The joint is not likely to get *stiff or suffer from permanent disability* in young people.



Fracture of the scaphoid bone. The two nutrient arteries are shown: one entering at the tuberosity and the other at the middle of the extensor surface. The medial fragment is left without blood-supply.

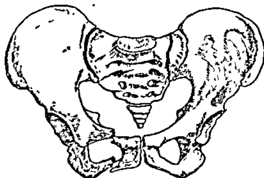
Fractures of the Scaphoid Bone

This bone is fairly frequently broken by *falls on the wrist joint*. *Typically*, the fracture goes through the narrow part of the bone, sometimes called the waist. The *diagnosis of the fracture* is fairly easy. There is fluid in the wrist joint; there is extreme tenderness on pressure in the *anatomical snuff-box* and over the dorsum of the scaphoid behind. There is great limitation of abduction and dorsiflexion. As a rule, *pain* is caused by *pressure* upwards on the head of the second metacarpal bone. This fracture takes very considerable time to unite and so immobilisation should be prolonged for 6 weeks. A dorsal plaster slab, such as is used for Colles' fracture, is the best method of fixation. In this case, however, it is better

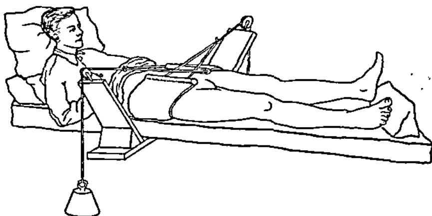
area of the pulp which it may be vital to preserve for the patient's occupation. Strapping traction is quite effective if carefully applied and supervised. An effective alternative is a Japanese matted straw finger-stall.

Fractures of the Pelvis

Fractures of the pelvis are due to severe crushes of this part of the body. The commonest site of the fracture is through the rami of the pubes. When such a fracture occurs there is usually a diastasis of the obliquely opposite sacro-iliac joint or a fracture which goes through the ilium close to this joint. Sometimes it is the symphysis pubis which gives way. Isolated fractures of the ilium also occur. These are very severe injuries associated with a great deal of shock; there is complete helplessness on the part of the patient; he cannot sit or stand; there are swelling over the region of the fracture and tenderness, the tender part usually being situated over the pubic rami in the front. There will also be tenderness over the opposite sacro-iliac joint behind. Pain is produced by pressing the iliac bones together. The gravity of these injuries does not depend solely upon the fracture, but is sometimes due to the serious complications of injury to the urethra or bladder or, *much more rarely*, to the rectum.



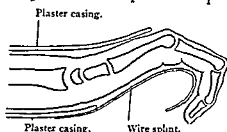
Typical fracture of pelvis; through the rami of the pubis on one side and the sacral ala on the other.



Apparatus for fracture of pelvis.

tying the traction string to a wire splint which has been incorporated in the plaster. Or after reduction by an open operation the replaced metacarpal can be kept in position by two small nails driven into the trapezium (Ellis). After 6 weeks' fixation in plaster, these nails should be removed to avoid their setting up an osteoarthritis.

Fractures of the other four metacarpal bones are commonest in the middle of the shaft; they are easily detected by a point of local tenderness, the swelling and discoloration on the dorsum of the hand and pain at the fracture site when the head of the corresponding metacarpal bone is pressed upon. Moreover, in the normal hand, the heads of the third, fourth and fifth metacarpal bones lie in one line; disturbance of this relation will also point to displacement. Frequently no displacement occurs, when it is sufficient to apply the dorsal splint to the lower two-thirds of the forearm and the dorsum of the hand as far as the metacarpal bones. In less favourable cases it is necessary to apply traction in order to maintain the fragments in good position. All fractures of metacarpal bones and phalanges should be treated in the semiflexed position; a plaster bandage surrounds the lower two-thirds of the forearm and extends along the dorsum of the hand; a wire finger splint (of the Cramer type) is bent to fit the corresponding finger which has been semiflexed into the palm. This is fixed on the palmar surface of the plaster and to this the corresponding finger is bandaged. This finger should have a strapping traction arrangement applied to it, or a Japanese finger-stall, and the traction string should be pulled up and fixed to the plaster bandage round the forearm. The uninvolved fingers should be left free for movements.

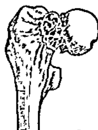


The position in which the hand should be maintained in fractures of the metacarpals or phalanges.

Fractures of the Phalanges

Fractures of the phalanges cause very considerable disability unless good anatomical reposition is brought about. They are treated in the manner just described for fractures of the metacarpal bones. It is essential that those fingers which are not broken should be allowed free movement, whilst the injured finger is maintained in the splint. Some surgeons hold that traction cannot be effectively produced by strapping on the skin and that there is some danger of strangling the finger. They recommend that a wire should be put through the pulp of the finger, by means of which a pull is obtained. This is objectionable because it leads to scar tissue formation in the sensitive

great pain and disability, he manages to hobble about; indeed, to continue going about until the fracture either disimpacts or he consults a doctor for the persisting pain. In ordinary cases the foot is externally rotated, there are a swelling in Scarpa's triangle deep to the femoral vessels and great tenderness here. This tenderness is due to the fact that the external rotation of the limb causes the broken surface of the fractured neck to point forwards. It is this projecting neck together with the surrounding haematoma which make up the swelling. At the same time there is relaxation of the iliotibial band. The great trochanter is not raised very much but, later, shortening may be very considerable. In fractures of the base of the neck there are some eversion of the limb, and helplessness, but the injury is more in the region of the trochanter, where there may be in addition very considerable bruising. Whilst fractures of the base of the neck tend to unite quite easily, fractures of the narrow part of the neck frequently result in non-union. This is because the blood-supply to the head is very inadequate to maintain nutrition. Blood reaches the head by means of the small artery running through the ligamentum teres. None of it can now enter by way of the neck though some may come to it from the upper surface of the neck through the retinacula ligaments, should they have remained intact. One reason for the need of extreme care in manipulating the limb is preservation of these ligaments and the prevention of any further damage to them. Sometimes the blood-supply of the separated head is so bad that it dies: this is rendered evident by examination with X-rays after some weeks, when the neck shadow will seem to have become less intense whilst the opacity of the head remains unaltered. There has been no absorption of lime salts. The poverty of the blood-supply of the head is one of the conditions which militates very strongly against early and firm union of the fracture; non-union, in fact, is very common after this injury has been sustained. Clearly, since all repair must take place from the neck, accurate apposition of the two fractured surfaces is an absolute essential in order that union shall occur. When reduction has been accurate a very prolonged period of immobilisation is necessary before a firm result can be obtained; indeed, this period may be as long as two years or even more. There are other general problems associated with fractures of the neck of the femur which are dependent upon the age at which the fracture takes place. These old patients are apt to die from hypostatic pneumonia if they are kept on their backs



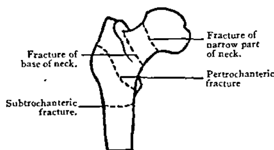
Position of fragments in fracture of neck of femur. The raw surface of neck points forwards forming *a tender lump in* Scarpa's triangle.

When the urethra is torn across, the injury usually takes place above the triangular ligament through the membranous part. When the bladder is implicated, it is usually a tear in the extraperitoneal part of the anterior wall, produced by the rough fractured end of the pubic ramus. In cases of suspected fracture of the pelvis, the condition of the urethra and bladder should be investigated before any further treatment is undertaken. The management of these complications is described elsewhere (pages 704 and 750). In the treatment of these fractures the patient must be immobilised in bed for at least 6 weeks. Sometimes it is necessary to force the two sides of the pelvis together; at other times it is only possible to fix the bones in the position they have assumed, as no restoration to anatomical form is possible. A good plan is to wrap the pelvis round with a wide strip of sorbo rubber to the ends of which traction weights are applied which pull on opposite sides of the bed. This renders the nursing care of the patient very much easier than if he is simply left with a binder round his pelvis.

Fractures of the Neck of the Femur

Two fractures occur in this position: one at the narrow part of the neck near the head of the bone, called an intracapsular fracture, and one at the base of the neck near the trochanter, called an extracapsular fracture. As this latter is also often partly intracapsular, the terms fracture of the narrow part of the neck and of the base of the neck are preferable.

The fracture of the narrow part of the neck is common in old people; as age comes on the femur becomes very fragile in this situation and a very slight twisting movement will cause the bone to break. Such accidents occur by perhaps tripping over a step or slipping down in a room, without any great violence. Although the violence may appear very slight, in reality the force acting upon the neck may be quite great owing to the leverage effect of the whole length of the femur. The fracture at the base of the neck requires much more force to produce. It occurs, as a rule, in younger persons and may be due either to direct violence on the trochanter or to more severe indirect violence. In fractures of the narrow part of the neck the patient usually finds his limb absolutely useless, but sometimes impaction of the neck into the head occurs, so that, although he has

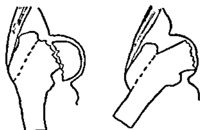


Fractures at upper end of femur.

pulling on the limb and rotating it strongly inwards. Reduction must be proved to have taken place by X-ray photographs, as shown in both antero-posterior and lateral views. With a Hey Groves guide a wire is driven from the trochanter through the neck into the head, and another photograph taken to verify its position. The wire should be in the required direction. If not, another must be put in. The length of a suitable nail is judged from the length of wire inserted. The nail itself has a central tunnel so that it can be threaded over the wire and driven into the bone. Fixation is so firm by this method that in the early days patients were allowed to be up and walking on the injured limb within a week. Experience has shown, however, that, though fixation is so good and use of the limb is possible, yet bony union is still likely to be extremely slow. Even at the end of a year displacement may occur so that, in addition to internal fixation, it is necessary to supply the patient with a walking caliper splint in order to remove the strain on the nail. One useful modification of this operation, which has been suggested, is the insertion of three Kirschner wires into the neck without the use of a nail at all. These prevent rotation, and they have the advantage that less of the cancellous tissue of the neck is destroyed. Probably, when the Smith-Peterson nail is employed, 60 per cent of patients will get bony union. The number of successes is greater in the younger patients.

Fractures of the base of the neck do not show this great tendency to non-union. They can be very well treated by traction of the limb suspended in a Thomas' knee splint in the abducted position.

Old ununited fractures of the neck of the femur may cause a great deal of disability from pain, and limping, to which they give rise. When there is no prospect of obtaining union by operating, in younger patients a reconstruction operation will enable the weight of the body to be transmitted again through the shaft of the femur and so relieve the patient of his pain. Three operations have been devised for this purpose. The Whitman reconstructive operation removes the head of the bone from acetabulum, smooths off the end of the neck and transplants the trochanter with its attached muscles to a lower position on the shaft. The upper extremity of the bone is then placed in the acetabulum in a position of abduction. In the Lorenz operation an oblique osteotomy is

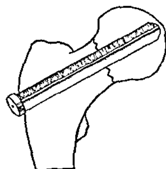


Whitman's reconstructive operation for ununited fracture of the neck of the femur. The head is removed, the great trochanter cut off and fixed lower down on the shaft.

in some immobilising apparatus, so that the older surgeons declared that the patient must be treated first and the fracture second. In fact, very frequently the patient was sat up in bed with his leg simply placed between sandbags. No method of treatment could be worse than this because the limb being immobilised on the mattress, the slightest movement of the patient disturbs the site of the fracture, gives him pain and increases his shock. If it is thought that the patient is so feeble that he cannot stand the ordinary methods of treatment, he should be fitted with a Thomas' knee splint and a strapping traction apparatus applied to the limb which is attached to the distal extremity of the splint. The splint is then slung up to an overhead beam in an abducted position. Even by this simple method union can be attained.

Whitman's method of treatment is the immobilisation of the reduced fracture in a plaster case which reaches from the axilla to the lower third of the leg on the injured side and to just above the knee on the sound side. The limb is abducted and internally rotated; a cross-bar joining the thighs just above the knees adds to the strength of the apparatus. Whitman maintains that, by this position of abduction and internal rotation, the two fractured surfaces are brought into apposition and maintained there by the plaster, and that the whole patient can be moved about with his case. Especially can he be tilted to avoid the onset of hypostatic pneumonia. Prolonged immobilisation is necessary. The results have not been quite so satisfactory in this country as in the hands of Whitman, but possibly 60 per cent of fractures unite.

Of recent years a technique for internal fixation of the two fragments has been evolved. Long ago screws and nails were driven through the great trochanter, through the neck and into the head, in order to act as internal splints, but the success obtained by such methods was not very great. The reason was apparently that such a tremendous torsion force was brought to bear on the site of the fracture by the leverage of the whole of the lower limb that rotation was not prevented by the perforating screw or nail. Smith-Peterson got over this difficulty by making a nail which really consists of three flat radiating blades; such nails driven into the head prevent rotation. In order to insert one of these nails correctly, the fracture must be first accurately reduced. This is done by anaesthetising the patient, preferably on an orthopaedic table,

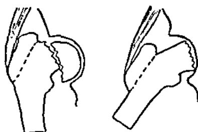


The three-bladed Smith-Peterson pin and its use for fracture of the neck of the femur.

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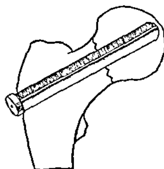


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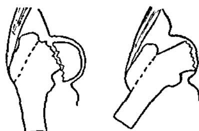


The three-bladed Smith-Peterson pin and its use for fracture of the neck of the femur.

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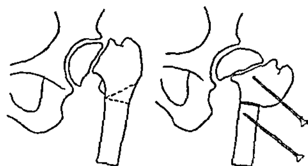
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Whitman's reconstructive operation for ununited fracture of the neck of the femur. The head is removed, the great trochanter cut off and fixed lower down on the shaft.

performed immediately below the lesser trochanter; the upper extremity of the shaft is then pushed upwards and backwards against the lower border of the acetabulum. A bifurcated upper extremity of the bone is thus produced and the patient again is able to transmit his weight through the femur. Both these operations give great relief. The Pauwel operation aims at bringing the line of fracture within 30° of the horizontal. The weight of the body transmitted through the head to the neck of the femur has a component perpendicular to the fracture line which tends to force the two broken surfaces together, and a component parallel with the fracture line tending to make them slide over one another. This second shearing force becomes greater the more vertical the fracture is. When the fracture line is inclined to the horizontal at an angle of 30° or less the shearing force is negligible; nearly all the weight of the body acts to force the two fractured surfaces together and promote union. Pauwel took advantage of these facts. A wedge is removed just below the lesser trochanter sufficient to bring the fracture line down to 30° of the horizontal. Two long pins, one through the trochanter and neck into the head, the other in the shaft just below the section, are incorporated in the plaster casing to keep the bones in the correct position during the early stages. They are removed in about 8 weeks' time when the patient is allowed up on crutches. Even long ununited fractures have been made to join up by this method.

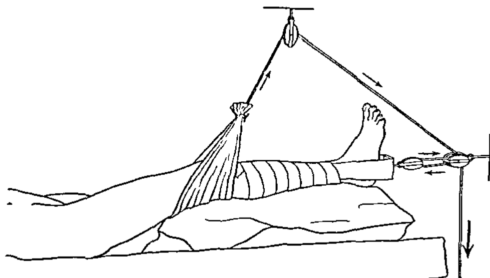


Pauwel's *osteotomy for ununited fracture of neck of femur.* The screws are incorporated in a plaster of Paris spica.

Fracture of the Shaft of the Femur

Fractures of the shaft of the femur are divided into fractures of the upper third, fractures of the middle third and fractures of the lower third. The commonest fracture of the femur is that of the middle third and it is usually due to indirect violence though it also occurs in run-over accidents by the agency of direct force. The ordinary oblique fracture is associated with considerable shock, which is very greatly increased by any jolting in the transport of the patient: in fact, many lives have been lost by insufficient immobilisation as a first-aid measure when the patient must travel some distance over a

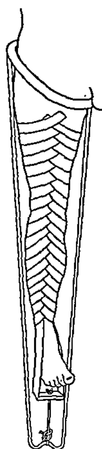
perhaps bumpy road. The limb lies rotated outwards; it is quite helpless and, if its lower part is raised, it will bend in the middle of the thigh. There is considerable shortening, the lower fragment being pulled upwards by the hamstrings, adductors and the rectus femoris behind the upper fragment. When it is compound, it is the lower pointed extremity of the upper fragment which is driven through the skin in front. The best emergency treatment is to fix the limb in a Thomas' knee splint, bandaging the boot to its lower extremity. In the subsequent treatment traction will be required to overcome the overlapping. There are two ways by which this can be done: (1) Strapping Traction: A long piece of strapping is carried down



The Hamilton Russell arrangement for fractured femur. The limb rests on pillows. The *upper pulley should be vertically above the junction of the upper and middle thirds of* the tibia.

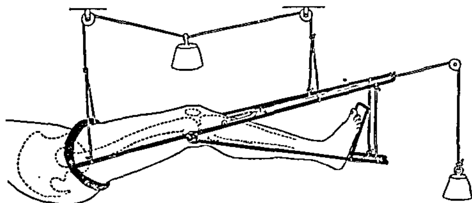
the inner side of the limb, from the upper third of the thigh to 3 inches beyond the foot, where it is stuck to a wooden stirrup and is brought up the outer side of the limb to the same level above. The object of the wooden stirrup is to prevent pressure sores on the malleoli; hence it must be a little wider than the distance between these two bony points. A cord is attached to this piece of wood, and the long strip of strapping is fixed to the skin by obliquely running and overlapping circular strips placed the whole way up the limb. In strapping traction, also called skin traction, the pull is transmitted from the skin to the deep fascia and thence to the muscles. (2) Skeletal Traction: In this the bones themselves are pulled upon directly by a pin which is driven, either through the tibial crest, just below the tubercle, the better place, or through the lower end of the femur, a finger's breadth above the adductor tubercle. Kirschner's wires are

used for this purpose more often than thicker pins; they are preferable because less damage is done to the bone and there is less liability to infection. There is no danger of injuring the ligaments of the knee joint by pulling upon a pin inserted through the tibia if there is a fracture of the femur, for in this case the separated lower part of the femur is only a kind of appendage to the tibia. In either case the cord from the stirrup is passed over a pulley and a weight is attached to it. The limb must be supported in some sort of splint, and the most convenient, as a rule, is a Thomas' knee splint. Some precaution must be taken to prevent the foot from rotating outwards: this is usually done by attaching a light wooden foot-piece to the sole from which a cord and light weight run over a pulley fixed to the overhead beam which itself supports the Thomas' splint. The weight required to pull fragments into proper position may be very considerable, perhaps in the neighbourhood of 30 lb. Such a great weight can be used with skeletal traction, but skin traction will scarcely allow of such a great force to be used without its slipping. That is one advantage of skeletal traction. Such great weights, however, are only necessary because the pull is not quite constant; it is apt to be relieved owing to nursing exigencies. Every time such relief takes place the muscles contract up and part of the work of the weight has to be done over again, so that fixed traction as distinguished from weight traction has certain advantages. In fixed traction the Thomas' knee splint is used with strapping traction which is fixed to the lower end of the splint. Twice a day, at least, this traction must be investigated because, as the muscles relax, it will become loose and must be tightened up until, finally, the limb becomes the same length as the normal one and the fracture is reduced. Fixed traction is very good in principle, but it has the one great disadvantage that the point of counter-pressure by the upper ring of the splint on the tuber ischii is likely to cause a pressure sore unless the sister in charge gives unremitting attention to this area of skin. There is so much loose tissue here that it is quite possible to push the skin aside and ensure that different areas are pressed upon, but a better method of avoiding pressure sores is to tie to the bottom of the splint a cord which runs over a pulley and has a weight attached to it. This weight must be



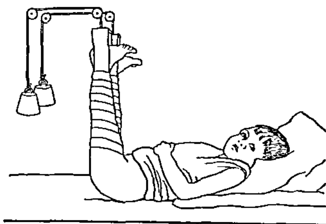
Fixed traction with strapping for fractured femur.

less than the actual pull on the foot. If the pull on the foot to the end of the splint is, say, 15 lb., the pressure on the tuber ischii must also be 15 lb. If the whole splint is then pulled on by a weight of 12 lb., the residual pressure on the tuber ischii will then be no more than 3 lb. This is a very efficient way of treating fractures of the



The principles of the method of treating a fractured femur by fixed traction, a pin having been put through the tibia, and a weight attached to the end of the splint to lessen the pressure on the tuber ischii.

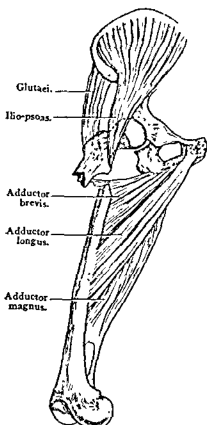
shaft of the femur. When a straight Thomas' splint is used a long posterior splint should be applied with a pad under the knee to produce about 15° flexion. This eliminates the danger of the knee becoming stiff. A pad may also be necessary behind the middle of the femur to preserve the normal slight anterior curve. A bent posterior splint will be necessary with the apparatus depicted above. Sometimes lateral splints are required to control deformity.



Method of putting up a fractured femur in infants.

Another method, shown in the diagram, was devised by Hamilton Russell. The pull on the femur should be transmitted to a point which lies above the junction of the upper and middle thirds of the tibia. Care must be taken to see that the normal anterior bowing

of the femur is preserved by supporting the thigh underneath at its middle. This applies to every method already described.

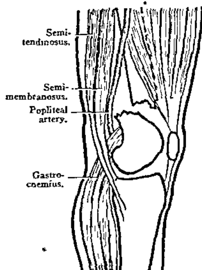


Displacement in fracture of upper third of femur.

In young children up to 3 or 4 years of age, skin traction is applied to the limb, which is tied to a beam in a vertical position so that the pelvis is just raised off the bed, the traction being thus caused by the weight of the patient. It is better to suspend both limbs in this way. The position is comfortable for the child and the nursing of the baby is very much simplified.

Fracture of the Upper Third of the Shaft

In this fracture the upper fragment is flexed. It is also abducted by the glutaei muscles and rotated outwards by the psoas. The lower fragment is rotated outwards by the weight of the limb and drawn upwards by the powerful long muscles. As it is impossible to control the position of the upper fragment by splinting, it is necessary to bring the lower fragment into line with it. This means that the thigh must be placed in a position of abduction, flexion and some external rotation. If it is put in this position the fracture can be treated by traction in a bent Thomas' knee splint, just as a fracture of the shaft.



Displacement in fracture of lower third of femur.

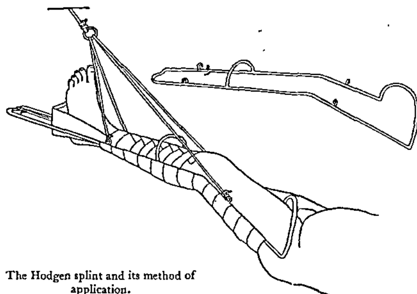
Fracture of the Lower Third of the Shaft of the Femur

In this fracture the lower fragment is rotated backwards by the gastrocnemii muscles and pulled upwards behind the main part of the shaft, which sometimes penetrates the quadriceps and the skin in front. Here, also, it is impossible to control the position of the lower fragment so that the limb must be placed in a position with the knee fixed. The bent Thomas' splint can be used. Another

useful splint for fractures of the upper third and lower third of the shaft is Hodgen's splint, which is depicted in the figure below.

Separation of the Lower Epiphysis of the Femur

This is a rare fracture of the femur, which can occur only in young people as a result of some severe wrench. The epiphysis



The Hodgen splint and its method of application.

moves forwards and the shaft backwards, where it may press upon the popliteal vessels. There is no real difficulty in reducing this fracture. It is done by traction on the bent knee, when the parts can be manipulated into place. It should be treated with the knee flexed to a right angle, in which position it can be maintained by plaster of Paris. The object of this position is to cause the quadriceps muscle to be stretched over the situation of the fracture and so maintain the fragments in place.



Forward displacement of lower epiphysis of femur.

Fractures of the Condyles of the Femur

One or other condyle may be broken off or a Y-shaped fracture may separate the condyles from each other and from the shaft. As in the case of the corresponding fracture of the humerus, it is essential to get the fragments into accurate anatomical position, otherwise there will be an irregularity of the joint surface

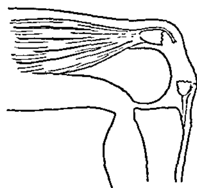
and considerable disability in the future. There are many surgeons who advocate an open operation for the reduction of the fracture. This should be avoided if possible, as the added trauma is very likely to lead to stiffness of the knee joint. By using strong skeletal traction on the tibia and lateral compression on the two condyles, it is usually possible to get the bones into position. When this has been effected the limb should be put into a plaster of Paris casing and must be immobilised for 8 weeks or more for union to occur. The traction must be kept up for at least 6 weeks.



Y-fracture of the lower end of femur.

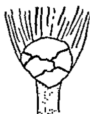
Fracture of the Patella

There are two varieties of fracture of the patella, the indirect and the direct. In the indirect fracture the bone is broken transversely by the leverage action of the quadriceps muscle, when the bone is poised over the condyle of the femur in a position of slight flexion. If a man tries to save himself from slipping backwards, the sudden contraction of the quadriceps extensor muscle puts a great strain on the patella and may cause it to break. The bone apparently gives way first and is dragged up by the tendon of the muscle under the expansion which lies in front of it. If the violence is continued this expansion is soon torn, with the result that, on dissecting such an injury, there is a fringe of tissue formed by the periosteum in front of the bone which is found to be curled in between the two fragments.



Transverse fracture of patella. Note how the upper fragment has been dragged upwards under the expansion of the quadriceps in front.

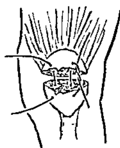
The amount of separation of the bone depends very largely upon the amount of tearing of that part of the expansion of the quadriceps situated at the sides of the patella. The direct fracture is produced by a fall or blow on the knee-cap and is a stellate one. There is no tearing of the periosteum or quadriceps expansion, so that the fragments of bone remain in their normal position. The diagnosis of fracture of the patella is usually quite easy. Sometimes a patient has heard the crack of the bone disrupting. He finds he is quite unable to extend the leg at the knee, although sometimes walking is possible by



Stellate fracture of patella.

keeping the knee in hyper-extension. Whether the fracture is due to direct violence or muscular action there is an out-pouring of blood into the knee joint, the amount of fluid in it being considerably increased by inflammatory exudation. In transverse fractures the gap between the two fragments is easily perceptible and the edges of the fragments are exquisitely tender.

In the case of stellate fractures of the bone where there is no displacement, and transverse fractures where there has been no separation, as shown by X-rays, the treatment is quite simple. The limb is encased in a plaster of Paris bandage from the upper third of the thigh to the lower third of the leg in a position of extension; but the situation is very different in transverse fractures, because here, invariably, it is impossible to obtain bony union without operation. It is comparatively easy to drag the two fragments down into apposition, but only fibrous union will result because of the interposing periosteum, which is a barrier to the passage of osteoblasts. Such a fibrous union is never strong enough to withstand the strain of ordinary activity. It invariably stretches and causes weakness of the limb. Hence, wherever there is no general contra-indication, such as an intercurrent illness or local complication as the presence of wounds at the site of the operation, this fracture should always be treated by the open method. It is better to wait 4 to 7 days after the accident to allow the acute traumatic synovitis to subside. It is also claimed by doing this that the resistance of the knee joint to infection is increased. The fracture is exposed by turning down a flap of skin, the blood-clot removed from the joint, the periosteum between the fragments replaced in its proper position, and a wire suture of the bone, or a simple suture of the quadriceps expansion, carried out. Suture of the bone seems preferable on the whole, as it allows of earlier safe movement in the knee joint. Union is likely to be slow but the results are extremely good. There is a certain remaining weakness of the bone which predisposes to a second transverse fracture. No splint is necessary after the operation. The patient should be walking in a plaster cast within a fortnight.


The wiring operation for transverse fracture of the patella.

Removal of the fragments and suture of the torn quadriceps expansion has been recommended and practised for both transverse and stellate fractures on the grounds that it is difficult to get such perfect apposition of the bone that the complication of osteoarthritis shall be avoided. Experience shows that this fear is much exaggerated. A knee joint deprived of its patella works at a

mechanical disadvantage, besides being very ugly to look at. Moreover, should the sutured expansion give way, as it does sometimes, the surgeon is faced with an irremediable condition of weakness. Only when, in a comminuted fracture, a fragment is so displaced that it projects inwards from the articular surface and cannot be replaced should it be removed.

Sometimes when violence, which usually causes a fracture of the patella, is applied to it the bone does not give way but the quadriceps tendon ruptures, or even the ligamentum patellae. In both these cases careful suture of the torn structures must be carried out, but prolonged immobilisation in plaster must be insisted upon or the sutures will give.

Fractures of the Tibia

Fracture of the Spine of the Tibia

This is a rather uncommon injury, in which the spine of the tibia is separated from the upper end of the bone with a crucial ligament attached. The limb should be placed on a splint in the extended position which will almost certainly bring the fractured surfaces into apposition. This immobilisation must be maintained for 2 months, as union of bone in a joint cavity is rather slow.

Fracture of the Upper End of the Tibia

The upper end of the shaft of the tibia is sometimes broken, either one tuberosity being separated off, or both, in a T-shaped manner. This is a very serious injury because it is associated with severe damage to the knee joint, and unless the upper articular surface of the tibia is restored to normal a crippling osteoarthritis is likely to occur in the future. If only one tuberosity is broken off, it is sometimes possible to reduce it by manipulation. If it cannot be brought into position it must be replaced by an open operation, or by levering it into position with a bradawl thrust through the skin, whilst the bone is being observed under the X-rays. Fractures of the tuberosities of the tibia are one of the few cases in which it is sometimes wise to wait a few days before reduction in order to allow for the subsidence of the acute traumatic synovitis in the knee joint. The same state of affairs exists as in the case of a fractured patella, and similarly it is a good plan to aspirate the joint during this period. When both


Fracture of inner tuberosity of tibia.

tuberosities have been separated off, a pin should be run through the lower end of the tibia and fibula, the patient placed on the orthopaedic table and strong traction exerted. When the limb has been restored to its proper length, the two tuberosities are pressed together. For this purpose the clamp used in treating fractures of the os calcis is very useful. The whole limb should be put into plaster of Paris from the upper third of the thigh to the ankle, and a traction weight of 6 lb. should be left on for about 6 weeks. When the weight has been removed, immobilisation in plaster for another 4 or 6 weeks will be necessary.

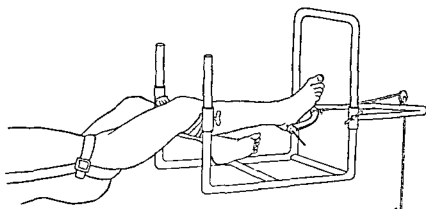
Fractures of both Bones of the Leg

It is very common to have an oblique fracture of the tibia in the lower third combined with a fracture of the fibula higher up. The line of fracture in the tibia runs from behind, downwards and forwards, so that the pointed lower extremity of the upper fragment is liable to penetrate the skin in front, thus rendering the fracture compound. In addition to these oblique and spiral fractures, transverse fractures also occur. In the treatment of these fractures traction is usually just as necessary as in fractures of the femur. The best position for the limb to be in is one of flexion at the *knee joint with the leg horizontal.* Many surgeons use a Braun splint for this fracture, but a bent Thomas' knee splint is preferable, *as the limb can be slung from an* overhead beam. This principle of slinging the lower limb when it is fractured is very important, because, if the splint lies on the bed, the part of the limb distal to the fracture is fixed and any movement of the patient's body is calculated to disturb the position of the fragments, whereas if it is slung there is that give which allows them to remain in contact. Skeletal traction is most effective although strapping traction is also of use and is, of course, employed when damage to the skin renders the insertion of a pin unwise. The pin can be placed through the lower ends of the tibia and fibula, in which case it is inserted from the fibular side, but more commonly it is placed through the *posterior*



Fracture of both bones of th leg. The fibula gives way higher up than the tibia.

part of the os calcis. A pull of 6 lb. is usually sufficient. This traction will usually bring about satisfactory reduction in 1 to 2 days, but the weight may have to be increased temporarily. Lateral displacement can be controlled by a screw attachment which fixes on the side bars of a Thomas' splint or slings round the limb. Weight traction should be kept up for 5 or 6 weeks, when the limb can be placed in a plaster of Paris casing which extends from the middle of the thigh to the heads of the metatarsal bones. A walking iron is attached to this splint so that the patient can get about. Some of these fractures are very difficult to get into position or to maintain in reduction. In these very refractory cases the procedure recommended by Böhler is perhaps better than an open operation. Böhler's method is to transfix the



Böhler's traction apparatus used for reducing a fracture of the leg.

tibia just below the spine above and just above the ankle joint below. Strong traction on the two pins is maintained by a screw device attached to an iron frame. Powerful traction will nearly always bring about reduction, and whilst the limb is in the frame a plaster of Paris casing is applied which surrounds the pins and fixes them. After 6 weeks the casing and pins can be removed and the fracture treated as above. As has been mentioned before, open operations on simple fractures are always to be avoided if possible, particularly in the case of the tibia, as they lead to delayed union. Simple fractures of the lower third of the tibia are in fact very slow in uniting in any case and may take 10 weeks or more to do so.

Pott's Fracture

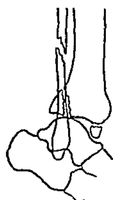
A Pott's fracture is really a fracture-dislocation at the ankle joint. It is caused, as a rule, by violent abduction of the foot at this point. The lateral malleolus is levered outwards around the inferior interosseous ligament as fulcrum and breaks about 1½ inches from the lower end. At the same time, the medial ligament is torn or the

medial malleolus of the tibia avulsed, whilst the foot, as a whole, is pushed backwards. There is considerable swelling, fibular deviation of the foot, pointing of the toes and great tenderness over the site of the fracture of the fibula and at the medial malleolus of the tibia. As in all fractures of the tibia, it is essential to have the line, along which the weight of the body is transmitted, passing through the middle of the upper articular surface of the astragalus. If a Pott's fracture is not efficiently reduced, this line will pass through the medial side of the astragalus, thus throwing a great strain on the medial ligament of the ankle joint and the whole of the medial side of the foot. Great pain will be experienced after use, and the arch of the foot will flatten. In reducing a Pott's fracture it is necessary to have the knee joint flexed so as to relax the pull on the tendo Achillis and to exert traction on the foot, which is kept at right angles with the leg, whilst the heel is pressed forwards and the lateral side of the foot pushed medially. If the medial side of the patella, the medial malleolus and the medial side of the metatarsophalangeal joint of the great toe lie in the same plane, the fracture is reduced. Whilst in this position, a slab of plaster running from the lateral side of the dorsum of the foot downwards beneath the sole, and upwards along the medial side of the leg to the upper extremity of the tibia, is applied and fixed with a muslin bandage. Another plaster slab runs from the same point above, downwards, behind the leg, round the heel and forwards to the tips of the toes. This is also fixed with a muslin bandage, and then the whole limb is encased in an encircling plaster of Paris bandage from the upper end of the tibia to the roots of the toes. The toes must always be left exposed on the dorsal aspect so that the circulation of the foot can be continuously under observation. The cast must be split at the slightest hint of serious embarrassment of the blood-flow. The patient lies in bed for 3 or 4 days with his foot slung to a cradle or overhead beam. At the end of this time it is possible to fix a walking iron and let the patient get up. Fixation apparatus should be left on for 6 weeks. Sometimes the force causing the fracture is so severe that the inferior interosseous ligament is ruptured and the astragalus passes upwards between the bones. This is called a Dupuytren's fracture of the ankle. It is reduced in the same way as the Pott's fracture, but the patient should not be allowed to walk as in the case of the simple Pott's injury. Another serious complication of a Pott's fracture is when the posterior margin of the tibia is broken off at the same time as the fibula is fractured. In this case a pin should be put through the os calcis and strong



Pott's fracture.

traction exerted until reduction has been brought about. When this has been effected an unpadded plaster splint is applied in the same way as for a Pott's fracture, but it should be immediately split down the front, as interference with the circulation is otherwise likely to occur. Traction must be maintained, as in fractures of the shaft of the tibia, for about 6 weeks. At the end of this time a walking plaster can be fitted.

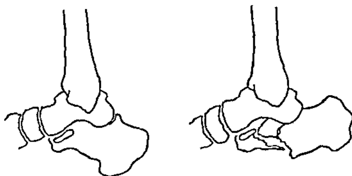


Pott's fracture with separation of posterior margin of the tibia. Note the backward displacement of the foot.

Pott's fracture by inversion is the opposite of the ordinary Pott's fracture. In this case the medial malleolus is broken and the lateral ligament is torn; the foot is displaced medially. It is treated as the ordinary Pott's fracture.

Fractures of the Os Calcis

The os calcis is fractured, as a rule, by falls *on the feet.* *Whilst the bone may* be crushed in several fragments, usually there is a transverse break which runs through the calcaneo-astragaloid articular surface, whilst a sagittally *running fracture splits off the lateral portion of the bone.* The posterior part of the calcaneus is dragged upwards by a pull on the tendo Achillis so that, instead of the inferior surface of the bone running upwards and forwards as it normally should in its back part, it runs either horizontally or slightly downwards. Unless the bone is restored to its normal shape, this fracture causes very great disability, so that a man who has got an imperfectly reduced



Fracture of the os calcis. Compared with the normal foot there is much flattening of the arch.

fracture of the os calcis can never return to manual work. He is a permanent cripple who suffers considerable pain in getting about. The fracture is quite easily recognised clinically because it will be found that the swelling and effusion lie below the region of the ankle

joint, the movements of which are free. There are a broadening of the foot below the malleoli and a bony prominence beneath the lateral malleolus. At the same time it will be found impossible to invert or evert the foot. In order to reduce this fracture, it is necessary to transfix the posterior part of the os calcis with one pin and the tibia with another. The limb is then put in the screw traction apparatus of Böhler, which has been already mentioned in connection with fractures of the tibia, with the foot held at right angles. The posterior part of the os calcis is dragged down into its normal position, and when this has been done a screw clamp is applied so that the two padded thrusts are in contact with the lateral and medial surfaces of the os calcis. With this apparatus the fragments displaced laterally can be squeezed into their normal relationship. The foot and leg, with the pins in place, are encased in a plaster of Paris which extends from just below the spine of the tibia to the heads of the metatarsal bones and must be kept in plaster for at least 6 weeks. When the patient is allowed to walk he should be provided with a support for the arch. Some surgeons hold that the best results in fractures of the os calcis are obtained if the foot is merely slung to assist the subsidence of the swelling and active movements encouraged. The advocates of this method have yet to prove its advantage over methods in which reduction is attempted.

Fractures of the Metatarsal Bones

These fractures are produced very often by a crush of the foot, but sometimes they occur from what appears to be inadequate indirect violence such as the fracture of the metatarsal shaft, which is known as "march" fracture and occurs in soldiers who have marched for a long distance and indeed when they have not noticed any particular injury. In the majority of cases the fragments are in good position and all that is then necessary is to apply a plaster of Paris cast from the tips of the toes on the sole to the level of the tubercle of the tibia, but reaching down on the dorsum of the foot only as far as the heads of the metatarsal bones. If a walking iron is used with this cast the patient can get about in a few days. More seldom, after severe crushes, there is great displacement which is exceedingly difficult to remedy. In such patients an attempt is made to mould the bones into their proper form by exerting strong traction on the toes with the foot at right angles to the leg, the surgeon being enabled to get a good grasp of the toes by covering them with mastisol and gauze. Whilst traction is kept up the arch is moulded to its proper form and a plaster cast is applied. If the angulation of the metatarsals is allowed to persist permanently, very great disability is caused.

Injuries to Joints

Sprains

When a joint is moved beyond the limit of its normal range, some ligament must be torn. This is called a sprain of a joint. Whilst any joint may be sprained, the two common joints which are most affected are the knee joint and the ankle joint. In a sprain of the knee joint it is nearly always the medial ligament which is ruptured. Clinically there is an effusion into the joint, pain on movement, tenderness at the site of the laceration of the ligament, and pain referred to the spot at which by passive movements the injured ligament is stretched. The strength of the knee joint depends upon the integrity of its ligaments; hence it is extremely important that the tear should heal up without any lengthening. This means that the medial ligament must be kept relaxed for 3 weeks. It is said that a sprain of the knee joint predisposes to a subsequent injury of the semilunar cartilage which is attached to the ligament. This is an additional reason for taking every precaution to ensure an effective repair. The knee joint should be aspirated to remove the effused fluid and then immobilised by two Cramer splints, both of which extend from the upper third of the thigh to the lower third of the leg. The wider of these is placed on the posterior aspect, the narrower is bent to fit the contours of the inner side of the limb. After being efficiently padded they are fixed with strapping and bandages. The patient should be allowed to walk within a day or two of the injury. It is perfectly safe for him to do so if his knee joint is fixed in this splint. If he is kept in bed and the limb is immobilised in plaster, great wasting of the muscles of the thigh will take place, so that the whole capsule of the knee joint will become lax. The result is a loose knee joint into which fluid is poured after even moderate use. This fluid will disappear after rest at night but will reappear every evening for months, in fact until the wasted muscles gradually regain their tone.

In the case of the ankle joint the sprain is usually produced by strong inversion of the foot, and the lateral ligament is the one that is lacerated. There is great swelling round the ankle joint and discoloration; tenderness over the site of the injury and pain is felt on passively inverting the foot, which puts the ligament under tension. Unlike the knee joint, the strength of the ankle joint lies in the adaptation of the bony surfaces to each other so that the immobilisation which can be effected by strapping the joint is sufficient. The limb should be used in walking in a day or two after the injury.

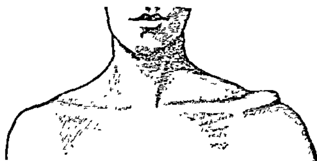
Other joints are sprained less commonly. They are treated by methods similar in principle.

(II) Dislocations

A dislocation is said to occur when the opposing articular surfaces of the joint are separated so that they can no longer be brought into contact. In describing a dislocation the terms backwards, forwards, lateral or medial are always applied to the distal bone entering into the formation of the joint. Thus, dislocation of the shoulder is said to be anterior when the humerus has moved forwards, and a dislocation of the hip joint is said to be posterior when the femur has been driven backwards on to the dorsum of the ilii. Dislocations cannot take place without severe laceration of ligaments and, very often, of the insertions of muscles. They are frequently very painful because the projecting bones are likely to press upon large nerves. Clinical signs are somewhat like those of a fracture, in that there are great swelling, discoloration and bruising of the injured area. Abnormal mobility, however, is replaced by abnormal rigidity. Instead of the joint being freely mobile, the bones, in their new situations, have very restricted movement.

Dislocations of the Clavicle

Dislocations of the Acromioclavicular Joint.—The common dislocation here is an upward displacement of the acromial end of the clavicle. The capsule of the joint is torn and perhaps the conoid and trapezoid



Dislocation of acromioclavicular joint.

ligaments. In the latter case displacement is much greater than in the former. The diagnosis is very easy. The lateral end of the clavicle forms a prominent projection under the skin, there are great tenderness around the region of the joint and pain on movement of

the arm. A dislocation is easily reduced but *also very easily recurs.* In fact there is a number of cases where it is impossible to keep the bones in their right relative positions unless an open operation is done. Yet, the disability which results from the bones becoming fixed in an abnormal position is often very slight and the shoulder is almost as strong as before.

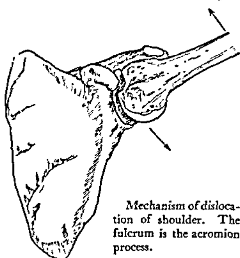
The best method of treatment is to employ that recommended for fracture of the clavicle: that is to apply two padded rings round the axilla and brace them together behind the back, whilst the elbow joint is supported by a sling and the upper arm bandaged to the side. Another method is to put a pad of felt over the outer end of the clavicle and another under the elbow bent at a right angle; long strips of strapping encircle these two points keeping the separated bones in contact. Five or six layers of strapping are necessary or stretching will occur, and new strapping over the old may need to be applied, in a day or so, to take up looseness. The wrist is slung to the neck. In cases where it is impossible to maintain the position, and this for some reason is desirable, an open operation should be performed.

Dislocations of the Sternal End of the Clavicle.—Dislocations may also occur at the medial end of the clavicle. This is a much less common injury, because the medial third of the clavicle is held down so strongly to the first rib by the rhomboid ligament. Violent falls on the shoulder will sometimes cause this ligament to give way, the capsule of the sternoclavicular joint to rupture and the bone to be displaced, usually forwards but sometimes backwards. In this last rare position interference with breathing may actually take place by pressure on the trachea. Both these dislocations are reduced by pulling on the upper part of the humerus, which is kept parallel with the side of the body, and at the same time pressing the shoulder back. They should be treated in the same retentive apparatus as a fractured clavicle.

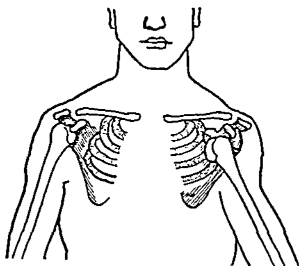
Dislocations of the Shoulder Joint

These occur as a result of falls on the outstretched hand or arm. The head of the humerus is levered out of the capsule, which is torn in its lower part, the fulcrum for this movement being the acromion process. The head of the bone first comes to lie on the lower edge of the glenoid fossa. In very rare instances it will remain poised in uncertain equilibrium in this situation (subglenoid dislocation). As a rule the head is pulled forwards by the strong action of the subscapularis and the pectoralis major, so that the head is dragged to the

front of the neck of the scapula and comes to lie under the coracoid process (subcoracoid dislocation), or if the violence is greater still and it passes further inwards, it is said to be a subclavicular dislocation. Quite unusually the head of the bone is dragged backwards by the lateral rotators, the latissimus dorsi and teres major muscles, when it comes to lie beneath the acromion process (subacromial dislocation), or even further back under the spine of the scapula (subspinous dislocation). This backward dislocation of the shoulder joint is almost as uncommon as the unstable subglenoid variety. For practical purposes we only meet with the anterior dislocations. Certain structures are always injured. They are, besides the inferior part of the capsule, the insertion of the infraspinatus and teres minor muscles to the greater tuberosity. Sometimes, indeed, the greater tuberosity itself is torn off. As the head travels forwards and inwards it tears the subscapularis from the front of the scapula, passes beneath the origin of the short head



Mechanism of dislocation of shoulder. The fulcrum is the acromion process.



Subcoracoid dislocation of shoulder.

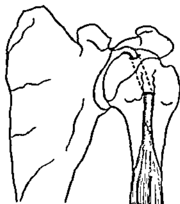
of the biceps and the coracobrachialis, pushing in front of it the axillary artery with the brachial plexus, which structures are often tightly stretched round the convexity of the head. The outline

of the shoulder is characteristically altered. There is a depression immediately below the acromion process where normally the projection of the head of the bone is seen. This depression lies higher than that which is characteristic of fracture of the surgical neck of the humerus. At the same time the infraclavicular hollow where the head itself lies is obliterated. It is possible to push the fingers in beneath the acromion process and actually feel the surface of the glenoid fossa. The axis of the humerus runs downwards and outwards. The elbow cannot be brought into contact with the side. It is impossible to put the hand of the affected side on the opposite shoulder. There is a lowering of the anterior axillary fold so that the circumference of the axilla on the injured side is greater than that on the other. A straight edge can make simultaneous contact with the acromion process and the lateral condyle of the humerus. The pain may be extremely great and is due to the pressure of the head of the bone on the large nerves of the brachial plexus. Reduction of this dislocation is usually effected by Kocher's manœuvre. Whilst a general anaesthetic, which causes muscular relaxation, is desirable, a dislocation can usually be replaced without an anaesthetic if sufficient time is taken to tire the muscles out by stretching. The elbow is first gradually pressed to the side of the body and then the forearm flexed to a right angle and gradually rotated outwards until it reaches a position just behind the coronal plane of the body. This gradual stretch may take three minutes or more. The elbow is then slowly raised to a horizontal position in front, at the same time being brought slightly across the body. At this stage the head will often be felt to slip back into place. If it does not, the head of the bone is rotated inwards by pulling the hand across so that it comes to rest on the opposite shoulder. Most dislocations can be reduced by this method.

A better method than Kocher's which sometimes is apt to damage the circumflex nerve, is to reduce the dislocation by direct traction on the arm with the elbow flexed. Sometimes the humerus will go back into place if it is pulled vertically downwards, close to the side of the body. If this is not successful, whilst traction is still maintained, the arm should be abducted gradually until it lies in the same line as the spine of the scapula, with the hand pointing forwards. Traction in this position, whilst the head is pushed backwards, will nearly always bring about reduction. A slight rotatory movement of the head is often of assistance. After reduction the forearm should be put in a sling and the arm bandaged to the body. In the after treatment, movements of the elbow joint and of the fingers should be carried out within a day or two and, within a week, the shoulder joint

should be rotated. Abduction should be left for 10 days or a fortnight. As dislocations of the shoulder joint are sometimes associated with injury to nerves, an examination for paralyses should be carried out before reduction is effected. The two nerves most frequently damaged are the circumflex and the inner cord.

Sometimes a dislocation of the shoulder is reduced and it almost immediately recurs. When this happens there is almost certainly a fracture of the greater tuberosity of the humerus so that the subscapularis is quite unopposed by the posterior muscles. In such cases the right treatment is to fix the greater tuberosity with a nail or bone peg. Patients are also met with who suffer from recurrent dislocations of the shoulder joint. Very slight injury will cause the head to escape from the glenoid fossa. They may have had these accidents on many occasions. It is quite easy to reduce them, but difficult to prevent another accident of the same kind. Numerous operations have been devised for recurrent dislocation of the shoulder. One of the simplest and best is to sling the upper end of the humerus to the acromion process by a piece of fascia lata or, better still, a piece of peroneus longus tendon.



Nicola's operation for recurrent dislocation of the shoulder. The divided long tendon of the biceps is put through a tunnel in the humerus.

Nicola's method is to divide the long head of the biceps a short distance below the groove in the humerus, and to thread it through a tunnel drilled through the upper part of the bone, emerging at the top of the articular surface. The tendon is then reunited after it has emerged from this tunnel.

Hey Groves passes a sling of fascia lata under the deltoid beneath the joint attaching it above to the acromial process. The operation is done through three small incisions; at the anterior and posterior margins of the deltoid and over the acromion.

Bankart lays stress on the fact that in recurrent dislocations there is a tearing of the glenoid ligament at the anterior margin of the glenoid fossa which fails to heal. He exposes the anterior aspect of the shoulder joint and repairs this rent in the capsule, suturing it to the bone.

The Treatment of Unreduced Dislocations of the Shoulder

If a dislocation has been overlooked or neglected, it becomes increasingly difficult to get the bones back into their proper place.

This is worth *trying until* 3 *months* have elapsed from the time of the accident. After this period, however, it is too dangerous to attempt forcible reduction by *manipulation*. *Very often*, particularly in old people, the limb is quite serviceable as a new false joint is formed on the anterior aspect of the neck of the scapula. *Under such circumstances*, if there is moderate function and there is no pain, the matter had better be allowed to rest. If, however, there is continued pain and severe disability, and particularly if there are signs of pressure on the brachial plexus, then an operation is imperative. Through an anterior incision between the deltoid and pectoralis major, the region of the dislocated head is exposed. Free access is obtained by chiselling off the tip of the coracoid process, with the coracobrachialis and the short head of the biceps attached. It is often possible to replace the head of the bone into the glenoid fossa, though the contracted subscapularis may require division first. If the surgeon should *fail in this effort he can excise the head of the bone*. The results of replacement are better than the results of excision of the head. Sometimes *a fracture of the surgical neck of the humerus is associated with* dislocation of the shoulder joint. In these cases it is sometimes possible, by traction on the arm and manipulation of the head, to reduce the dislocation, when the fracture is treated as an uncomplicated injury. If, however, reduction proves to be impossible by manipulation, the head must be exposed by an open operation in order to effect it. The fracture can then be treated as an uncomplicated injury.

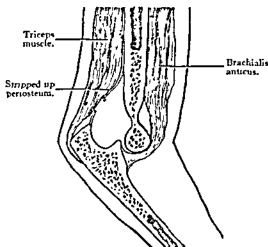
Posterior and Infraglenoid Dislocations of the Shoulder Joint

These are extremely rare. In the posterior dislocation there is the same hollow under the acromion but there is a prominence posteriorly instead of in front. The head can be felt just below *the spine* of the scapula or its continuation into the acromion process. Reduction is *brought about by traction in the abducted* position with the help of some rotation.

Dislocations of the Elbow

The dislocation of the elbow is a backward dislocation of both bones behind the humerus ; much more rarely, there is an anterior dislocation, and perhaps a little more commonly a lateral dislocation. In the backward dislocation the sigmoid notch of the ulna comes to lie right behind the humerus so that the coronoid process rests in the olecranon fossa. The forearm makes an obtuse *angle with*

the upper arm. There is great projection in the region of the elbow joint. The conformation of the ulna and head of the radius is very easy to feel behind, whilst the lower end of the humerus can be palpated in front. The posterior ligament of the elbow joint is apt to be stripped off the humerus, bringing with it some periosteum, so that there may result an ossification in the triceps (myositis ossificans), whilst the tearing of the capsule in front may produce a similar condition in the brachialis anticus. The median nerve may be stretched over the lower end of the humerus, but it is uncommon for any nerve to suffer damage in a dislocated elbow. The reduction is easily effected by traction upon the arm whilst, at the same time, the elbow is bent to a right angle and the two forearm bones pushed forward. It is usually effected with an audible snap. The elbow joint is very stable, so that there is no need to apply a splint; a simple bandage with a sling are all that is required. Also, too early movements should not be permitted; nor should massage be allowed, for fear of exciting the onset of myositis ossificans. If there should be any sign of this, the only treatment is to fix the arm in a plaster of Paris splint for 5 or 6 weeks. Lateral dislocations are easily recognisable and as easily reduced.



Backward dislocation of elbow joint.

Two fractures are associated with dislocations of the elbow joint. Posterior dislocation may be accompanied by a separation of the coronoid process of the ulna. When this happens it will be found that there is a great tendency to recurrence after the bones have been replaced in their proper position. It is necessary in this case to fix the elbow at a right angle in a plaster of Paris splint, the bones being held in position until the plaster is set. An anterior dislocation of the radius alone is sometimes associated with a fracture of the upper third of the shaft of the ulna. This injury is treated as a fracture of both bones of the forearm. The radius is easily got back into position when traction is made on the forearm. The limb is put up as described on page 576.

This is worth trying until 3 months have elapsed from the time of the accident. After this period, however, it is too dangerous to attempt forcible reduction by manipulation. Very often, particularly in old people, the limb is quite serviceable as a new false joint is formed on the anterior aspect of the neck of the scapula. Under such circumstances, if there is moderate function and there is no pain, the matter had better be allowed to rest. If, however, there is continued pain and severe disability, and particularly if there are signs of pressure on the brachial plexus, then an operation is imperative. Through an anterior incision between the deltoid and pectoralis major, the region of the dislocated head is exposed. Free access is obtained by chiselling off the tip of the coracoid process, with the coracobrachialis and the short head of the biceps attached. It is often possible to replace the head of the bone into the glenoid fossa, though the contracted subscapularis may require division first. If the surgeon should fail in this effort he can excise the head of the bone. The results of replacement are better than the results of excision of the head. Sometimes a fracture of the surgical neck of the humerus is associated with dislocation of the shoulder joint. In these cases it is sometimes possible, by traction on the arm and manipulation of the head, to reduce the dislocation, when the fracture is treated as an uncomplicated injury. If, however, reduction proves to be impossible by manipulation, the head must be exposed by an open operation in order to effect it. The fracture can then be treated as an uncomplicated injury.

Posterior and Infraglenoid Dislocations of the Shoulder Joint

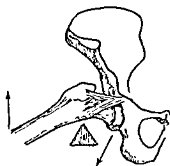
These are extremely rare. In the posterior dislocation there is the same hollow under the acromion but there is a prominence posteriorly instead of in front. The head can be felt just below the spine of the scapula or its continuation into the acromion process. Reduction is brought about by traction in the abducted position with the help of some rotation.

Dislocations of the Elbow

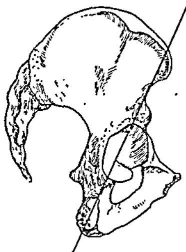
The dislocation of the elbow is a backward dislocation of both bones behind the humerus ; much more rarely, there is an anterior dislocation, and perhaps a little more commonly a lateral dislocation. In the backward dislocation the sigmoid notch of the ulna comes to lie right behind the humerus so that the coronoid process rests in the olecranon fossa. The forearm makes an obtuse angle with

Dislocations of the Hip Joint

The hip joint, being very stable, dislocations are rare and commonly the result of very great violence. They are nearly always due to forcible abduction of the hip joint, as, for instance, when a weight falls on the back with the legs rather widely separated. The capsule



Mechanism of dislocation of hip. The fulcrum is the attachment of the ilio-femoral ligament to the femur.



The line of junction of the two planes of the os innominatum.

of the hip joint is torn in its lower part. The lower attachment of the Y-shaped ligament of Bigelow acts as a fulcrum round which the head and neck rotate. If the pelvis be examined, it will be found that a ridge runs from the lower end of the acetabulum to the tuber ischii. At this ridge two planes meet. Just as the humerus, when it comes out of the lower part of the capsule of the shoulder joint, comes to lie on the axillary border of the scapula in an unstable position, so the head of the femur comes to lie on this ridge between the anterior and posterior planes of the os innominatum. As a rule the head will then slip backwards on to the posterior plane and reach the outer surface of the iliac bone (iliac dislocation), or perhaps come to lie over the sciatic notch (sciatic dislocation). If it moves forwards it will come to lie in the obturator foramen (obturator dislocation), or against the pubes (pubic dislocation). These anterior dislocations are far less common than the posterior



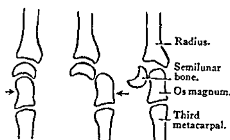
Posterior dislocation of hip.



Anterior dislocation of hip.

Dislocation of the Semilunar Bone of the Wrist

This is a curious accident which results in the semilunar bone of the wrist being pushed into the front of the joint and rotated so that it is attached to the radius by its anterior ligament only. The mechanism of this injury is peculiar. It is said that a fall on the hand causes the whole of the carpus, with the exception of the semilunar bone, to be displaced backwards upon the lower ends of the radius and ulna. It is, as it were, a backward dislocation of the wrist except that the semilunar bone remains attached to the radius. There would appear to be an elastic recoil so that the hand springs backwards into its place but the head of the os magnum pushes the semilunar bone forwards, rotating it so that its concave surface looks towards the front. After this injury there is great swelling in the neighbourhood of the wrist, stiffness of the wrist, a bony lump to be felt in front and, very often, great pain from pressure upon the median nerve. The bone can be made to go back into place by strong traction on the hand. Hyperextension should not be used, nor very hard pressure upon the bone in front, because by these means some damage of the median nerve may be caused. As a rule it is quite unnecessary to perform an open operation.



Stages in dislocation of the semilunar bone.

Dislocation of the Fingers

The interphalangeal joints are quite commonly dislocated but they are very easily replaced by traction and manipulation. They need not be splinted. It is sufficient to immobilise them with strapping. A rather important dislocation is that of the metacarpophalangeal joint of the thumb, backwards. In this the head of the first metacarpal comes to lie between the two sesamoid bones with their attached small muscles. The flexor longus pollicis comes to one or the other side. The anterior ligament is torn and sometimes is dragged between the bony ends so that it offers an obstruction to reduction. Most dislocations of this kind can be replaced by manipulation, but, now and then, all such efforts fail when it becomes necessary to make an incision in front of the joint and remove the interposing and obstructing tissue.

is rare. The patient should lie in bed for 3 or 4 weeks until the capsule of the joint has had time for repair. Anterior dislocations are reduced by a similar method, but medial circumduction is substituted for external movement.

Dislocations of the Knee Joint

Dislocations of the knee joint are also the result of very severe injury. The commonest is a lateral dislocation, but backward, forward and medial dislocations also occur. In the lateral dislocation the diagnosis is quite evident as the medial condyle of the femur forms a great projection on the medial side of the limb and the trochlear surface is palpable. The hamstring muscles come to lie between the condyles of the femur. The medial ligament is torn as are also the crucial ligaments. Reduction is quite simply performed by manipulation. After reduction the knee is encased in a plaster case extending from the upper third of the thigh to the lower third of the leg, in which it remains for at least 8 weeks in order to allow time for the torn structures to repair. This applies to all dislocations *of the knee joint. A lateral dislocation of the joint is sometime* associated with an injury of the medial popliteal nerve, whilst an medial dislocation is sometimes complicated by a lesion of the lateral popliteal nerve.

Dislocations of the Patella

Dislocation of the patella nearly always takes place in a lateral direction and occurs in women much more often than in men,



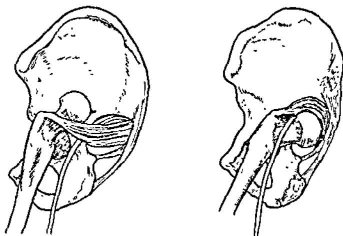
Lateral dislocation of the patella. Note the genu valgum.



The operation for habitual lateral dislocation of the patella.

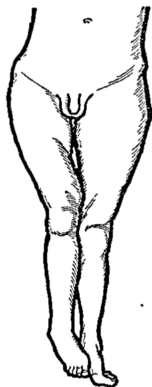
and particularly in those individuals who have a pronounced genu valgum. In such cases the pull of the quadriceps extensor and the

variety. In the posterior dislocation *there will be signs of local trauma and the limb will be held with the thigh slightly flexed and*



Dislocated hip. On the left an iliac dislocation. On the right the head of the bone is caught under the sciatic nerve emerging beneath the pyriformis muscle. On the left the head has slipped up under the pyriformis and missed the nerve.

adducted and inverted so that the foot on the injured side lies over *the sound foot. There is rigidity at the hip joint where there should* be free mobility. In Scarpa's triangle in front there is a great hollow. The head of the bone has disappeared but it *will be found forming a projection under the* glutaei muscles on the dorsum ilii. In the anterior dislocation the thigh is more extended. It is everted and slightly abducted. There is a flattening in the region of the trochanter and a projection in front of the pubes. For reduction of the ordinary dorsal dislocation the patient should be lying on his back and it is *better to have him on a mattress on the floor,* as the surgeon can then stand over him and exert greater traction upon the thigh. Deep anaesthesia is usually required. With the knee flexed, he pulls the thigh vertically upwards, then abducts the joint, *maintaining the traction* and, finally, laterally circumducts the limb to bring the two legs parallel. By this means the head is made to travel downwards, forwards, beneath the lower part of the acetabulum, upwards through the lacerated area *into the* acetabulum. It goes back with a snap. Sometimes great force is required but at others *reduction is comparatively easy.* There is some danger of the head hooking round the sciatic nerve and injuring it, but this accident



Position of limb in dorsal dislocation of hip.

is rare. The patient should lie in bed for 3 or 4 weeks until the capsule of the joint has had time for repair. Anterior dislocations are reduced by a similar method, but medial circumduction is substituted for external movement.

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Lateral dislocation of the patella. Note the genu valgum.



The operation for habitual lateral dislocation of the patella.

and particularly in those individuals who have a pronounced genu valgum. In such cases the pull of the quadriceps extensor and the

ligamentum patellae meet at an angle at the patella which is open laterally. When the muscle contracts it tends to bring these two structures into one line. If the lateral ridge of the trochlear surface of the femur is badly developed there is a great tendency for dislocation to recur. The dislocation is self-evident and the patella is very easily replaced by quite gentle manipulation. When it is recurrent the limb should be operated upon. Several procedures can be carried out. One of the best is to separate the tubercle of the tibia and to shift it inwards slightly so as to bring the pull of the quadriceps into line with the direction of the ligamentum patellae. Some surgeons do a simple plication of the inner side of the capsule of the joint, but this is not so effective. A quite good way is to split the ligamentum patellae longitudinally, separate the attachment of the lateral half, and, after passing it under the intact part, to fix it again to the tibia on the medial side.

CHAPTER XLV

DEFORMITIES

Coxa Vara

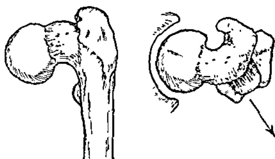
The normal angle which the neck of the femur makes with the shaft is 135° in children and 125° in adults. A diminution of this angle is called coxa vara and it results from two causes, either from a general softening of the neck which bends from its base to the head, or from a partial separation of the epiphysis of the head in the downward direction. *The former variety of coxa vara is seen in young children* as the result of rickets and sometimes comes on in older children towards adolescence, when it is also probably due to late rickets. This type of disease is called adolescent or idiopathic coxa vara. The type due to injury of the epiphysis is called traumatic coxa vara. There is another type of coxa vara seen in young children called infantile coxa vara which has some characteristic features.



Skiagram of adolescent coxa vara.

Adolescent Coxa Vara. — The deformity in this case usually comes on insidiously, but sometimes there is an *acute stage.* The whole neck bends so that the angle between it and the shaft of the bone is diminished. There also takes place a curving of the neck with a convexity projecting anteriorly, and at the same time there may be a twist of the neck in the direction which would occur if the head of the bone were immovably fixed in the acetabulum and the hip were hyper-extended. The condition is seen in adolescents who have grown rapidly and are very often too fat for their age. There is some pain after exertion and a limp. The diagnosis is easy, for the trochanter makes a very obvious projection in the outline of the hip, which is higher than on the normal side.

The affected limb is a *little bit shorter*, and two movements are restricted: abduction, because when this is *attempted the trochanter* comes into contact with the dorsum ilii before the movement has been completed; and internal rotation, because the *bulging anterior surface of the neck is brought up by contact* with the anterior margin of the acetabulum. There is usually some wasting of the glutaeal and thigh muscles and, owing to the mechanical disadvantage caused by *the raising of the* trochanter, the glutaei lose their power of abduction, so that Trendelenburg's test is likely to be positive. The deformity may be so extreme that if the condition happens to be bilateral there is scissor-leg progression.



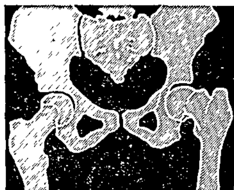
Coxa vara. The neck is curved forwards as well as curved upwards causing the foot to point outwards as the view on the right from above shows.

In the treatment of adolescent coxa vara it is essential to take the weight of the body from the neck of the femur in order to stop further bending and, if there have been any signs of accompanying arthritis in the hip, traction should be employed. Some surgeons recommend an attempt by forcible abduction to remedy the defect in the neck. After this has been done the limb is put up in a plaster of Paris *splint in the abducted position. After 6 weeks the patient can be fitted with* a weight-bearing caliper which he must wear for approximately one year. In extreme cases of adduction deformity a subtrochanteric osteotomy should be performed to assist progression and increase the range of movement.

Traumatic Coxa Vara.—In traumatic coxa vara there is some obscure pathological change in the metaphyseal region of the neck which facilitates displacement of the epiphysis. This movement results from an injury which may perhaps have been so trivial as not to have been noticed. It is never a very severe one. *The head slips* downwards and backwards on the neck and the growing surface of the epiphyseal cartilage now looks laterally rather than downwards, so that if the head is allowed to remain in this position subsequent growth will make a horizontal instead of an oblique neck and so perpetuate the deformity. The *signs of a slipped femoral epiphysis are* those of *adolescent* coxa vara described above.

The best method of treatment is to apply skeletal traction by a pin which pierces the lower extremity of the femur. This, in a recent case, will pull the neck of the bone down into proper *relation* with

the head of the bone. This method of reduction is very much superior to that of forcible abduction, for the latter manœuvre is liable to cause injury to the blood-vessels supplying the head, thus interfering with its nutrition, causing ischaemic necrosis and, later, osteoarthritis of the hip joint. Weight extension, by accomplishing the replacement gradually, seems to preserve the blood-supply.



Skiagram of traumatic coxa vara.

After 6 weeks' traction the patient should be allowed up on crutches for a month, and not allowed to put his foot to the ground. At the end of this time he should have a weight-bearing caliper fitted. Just as is the case in adolescent coxa vara, the condition is liable to be bilateral.

If coxa vara be detected before there is sufficient deformity to need correction, treatment is much shortened by introducing a Smith-Peterson pin which leads to early epiphyseal fusion.

When the deformity is great and skeletal traction fails to reduce it, no forcible attempt should be made nor should an open operation be done. Light traction should be employed until the epiphysis is fused in the position of deformity. Then a subtrochanteric osteotomy will restore the range of movement.

Infantile Coxa Vara.—This is a rather rare form of the condition seen in younger children from about 6 to 8 years of age, in which the X-ray shows a clear line running from the epiphyseal line downwards and outwards, indicating that close to the head there is a separate triangular fragment of bone in the lower border of the neck. In addition to this, ossification has not taken place normally in the head, which is much more translucent than usual. When the disease has persisted in older cases the triangular portion of bone grows out into a lip prolonged downwards round the lower part of the head. In later cases the neck is either quite long and projects downwards and inwards, forming an acute angle with the shaft of the femur, or sometimes there appears to be no neck present at all, the head being attached to the shaft very low down so that there may be two or three inches shortening.



Infantile coxa vara. Note the triangular fragment at the lower borderof the neck.

The treatment of these bad deformities consists in an osteotomy followed by traction in the abducted position.

Congenital Dislocation of the Hip Joint

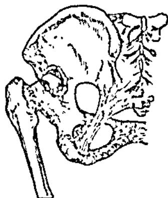
This condition is usually discovered in infants, at the period when they begin to walk, when a limp calls attention to some abnormality being present. It is not certain whether the dislocation occurs *in utero* or very shortly after birth. It is certain, however, that all these children have a very shallow acetabulum. In the position the foetus assumes *in utero* with acutely flexed hips, if there is much anteversion of the femoral neck, the head hinges on the lower and back part of the capsule of the joint and it is quite easy to understand how a comparatively slight injury would lead to a dislocation. The condition is much commoner in female children. This is associated with the more widely opened position of the innominate bones.

In an established case there are very distinct divergencies from the normal conformation of the bones and soft parts. The acetabulum is not only shallower but it is triangular in shape with the apex above. On the dorsum ilii, in long-established cases, there can be seen a false acetabulum which has been moulded by the head of the bone. The ischium may show a facet which articulates with the lesser trochanter. The head of the femur is smaller than normal and conical in shape. The capsule of the hip joint is elongated into a tube and the pelvis is suspended by this membrane. The ischio-capsular band is particularly thickened and, running over the neck, forms a sling which, rubbing on the neck, frequently makes a smooth articular surface in this situation. The ligamentum teres is stretched and thinned and may be absent, particularly in bilateral cases. There is frequently a constriction in the capsule of the hip joint which transforms it into an hour-glass-shaped structure, the isthmus forming an obstacle to reduction. The muscles which move the joint are, most of them, contracted, particularly the adductors, the hamstrings and the glutaei. The ilio-psoas, owing to the dislocation of the head, passes almost directly backwards to the lesser trochanter instead of passing obliquely downwards and backwards. It, therefore, acts with the greater force and

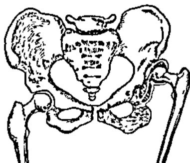


Congenital dislocation of the hip showing the triangular acetabulum, the conical head to the femur, and the facet on the upper surface of the neck.

the result is increased flexion of the pelvis on the hip and a pronounced lumbar lordosis to bring the body erect. This is particularly noticed in bilateral dislocations. On the other hand, the glutaei



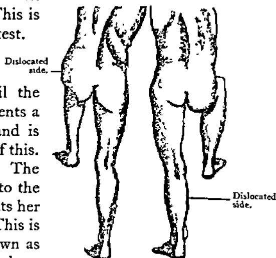
Congenitally dislocated hip from behind showing the strong ischiocapsular band forming a sling around the neck of the femur.



Congenital dislocation of the hip showing the tubular hour-glass capsule and the poor development of the femur on the affected side.

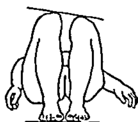
muscles act at a mechanical disadvantage. They have less power to abduct the hip or to prevent the pelvis from tilting downwards on the opposite side when the patient stands on the diseased side. This is the basis of Trendelenburg's test.

It has been already mentioned that the condition is frequently overlooked until the child begins to walk and presents a limp, or is late in walking, and is brought to a surgeon because of this. The diagnosis is usually easy. The limp is a lurching of the body to the good side when the patient puts her weight on the affected one. This is really the action which is known as Trendelenburg's test repeated at every step. This test is a lowering of the glutaeal fold on the opposite side of the body when the patient stands on the dislocated hip. When she stands on the healthy hip, the opposite glutaeal fold is raised because she has to bring all her weight so that the centre of gravity passes through the sole of her standing foot. She does this by tilting her pelvis, whereas, when she stands on the dislocated side, owing to the weakness of the glutaei muscles this is impossible. She



Trendelenburg's test for congenital dislocation of the hip. The opposite side of the pelvis falls when the weight is on the affected limb: when standing on a normal limb it is raised.

can only maintain her balance by compensating for the drop in the pelvis with a lateral curvature of the spine. When the child stands, the outline of the hip usually shows a prominence of the great trochanter of the femur a short distance below the crest of the ilium. In the fat thighs of infants two skin creases are visible on the inner aspect instead of a single crease on the normal side. If the condition is bilateral there will be noticed a space in the perineum between the upper extremities of the two thighs. On palpation there is a hollow in Scarpa's triangle where the head of the bone should normally be felt and a prominence just behind the anterior superior spine. The affected leg is short but can often be pulled down to the same length as the other (telescopic movement). If the child lies on her back with the knees drawn up, the shortening of the thigh can be demonstrated by the difference in the level of the knees. The movements of the hip joint are particularly free except that of abduction. In the X-ray the dislocation is very easily seen. The lower border of the neck no longer passes into the lower border of the iliopectineal line in one even curve which is known as Shenton's line.



Child with dislocated left hip. Note the slope of the knees, the wasting of the thigh, and the projecting trochanter.



Skiagram of congenitally dislocated hip.

The sooner this deformity is corrected the less likelihood of trouble in the future. If a congenitally dislocated hip is allowed to remain, the patient usually begins to suffer pain soon after puberty and this pain becomes worse later in life as the weight increases. It is due to all the strain of weight-bearing being thrown upon the capsule of the joint.

Up to 5 years of age the best treatment is to reduce the fracture by manipulation. This is done under anaesthesia and is usefully preceded by a period of strapping traction in order to stretch the shortened muscles. The hip is replaced by flexing it to a right angle, abducting it to the coronal plain of the body while an assistant steadies the pelvis, and then levering the head into the acetabulum over the fist used as a fulcrum under the great trochanter. The head can often be felt to go into the acetabulum with a click, and when it is in place the hamstring muscles go into tension so that the leg cannot be extended on the knee. Both limbs should then be maintained in this position of extreme abduction and flexion of the hip joint, with a plaster of Paris casing which should extend from above the crest of the ilium

to just above the ankle joint on the affected side and just above the knee on the good side. After a week or 10 days, the reduction having been confirmed by an X-ray examination, the child should be allowed to use the limb. If it is a small infant it should be allowed to crawl about on its stomach on a blanket on the floor. If it is an older child it is useful to have a low stool on wheels made on which the child can sit and paddle itself along with its feet. This use of the limb is very important because it helps to mould the acetabulum and increase its depth. After 3 months the plaster is removed and the limb partly lowered, still in the abducted position, and again fixed. Gradually,



Fixation of the reduced dislocated hip in extreme medial rotation. The hip joints and pelvis are free. Nursing is facilitated.

by the end of 9 months, with one or two more changes of plaster, the legs can be brought down into a parallel position. At the end of this time the plaster can be discarded.

After reduction, instead of fixing the limb in the flexed and abducted position, the hip joint may be moderately abducted and strongly rotated medially. This position is maintained by applying plaster from the upper third of the thighs to the ankles and joining the limbs by a transverse malleable iron bar incorporated in the plaster below the knees. This position is preferable if there is much anteversion of the neck and has the advantages of leaving the hip joints free to move and facilitating the nursing of the child.

Closed reduction by this method is worth trying up to the age of 7, but there are many failures after the age of 5. When a failure occurs or there is repeated re-dislocation, it is necessary to perform an open operation and divide the obstructing capsule which is usually the

obstacle to a satisfactory reduction. The joint is exposed by a Smith-Peterson incision, the capsule incised longitudinally right through the narrow isthmus, the hip replaced and the capsular wound sewn up transversely. The results of open reduction are not quite so good as those of the closed method. Recently Hey Groves has recommended cutting away the capsule proximal to the narrow isthmus, sewing up this aperture and then gouging out the acetabulum to form a deep hollow which will accommodate the head of the bone within its capsule. It is also claimed that skin traction in a Thomas' knee splint for 2 to 4 months will bring the head down opposite the acetabulum. When this has happened, by a Smith-Peterson incision, the joint is exposed and a shelf from the ilium turned downwards.

Some surgeons maintain that this skin traction should be the standard method for the ordinary case in young children. After the head has been brought down to its proper position, the limb is just fixed in position in the internally rotated position. It is not abducted.

In older patients, after puberty, when pain is complained of, relief cannot usually be brought by reducing the dislocation itself. There are three courses open. An arthrodesis of the hip joint may be performed, a shelf may be made above the acetabulum against which the head of the femur may take purchase, or a Lorenz bifurcation operation done.

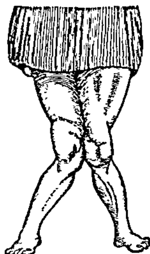
Arthrodesis of the hip joint abolishes the pain immediately but is not recommended because of the disability associated with a stiff hip and the fact that it is usually followed in a few years by pain in the back due to lumbo-sacral strain. The shelf against which the head of the bone can rest is made by exposing the surface of the ilium by a Smith-Peterson incision, chiselling off a portion of the crest of the ilium, which is wedged into this bone lower down, just above the situation of the head. Some very good results have been reported from this operation. It certainly is good in cases of old unreduced dislocations of the hip. The Lorenz bifurcation operation is an oblique osteotomy just below the lesser trochanter which runs upwards and medially. The upper extremity of the shaft is then forced against the lower border of the acetabulum. When the fragments unite a V is formed at the top of the femur which acts as a support for the acetabulum. The bifurcation operation is the simplest method of treating an unreduced congenital dislocation and gives very good results.

Genu Valgum

In genu valgum there is a lateral angulation at the knee joint so that the feet cannot be brought into apposition at the same time as the

knees. In other words there is knock-knee. There are two varieties of knock-knee: the rachitic knock-knee which is seen in infants and is due to a softening of the bones in rickets; and the knock-knee of adolescents, the pathology of which is not clear, though it is due to changes in the lower end of the femur which are indistinguishable from those seen in rickets.

In rachitic knock-knee the deformity is due to bending of the femur and sometimes of the tibia just above and below the knee joint. In young children the deformity is treated by the application of a splint on the outer side of the leg. The splint should reach from the level of the trochanters to several inches below the sole of the foot. A simple padded wooden splint, with webbing straps sewn to it, is quite effective. The object of the splint is to keep the patient from bearing weight on his limb and so increasing the deformity. In infants this is all that is usually necessary, but, in older children whom it is not advisable to keep from walking about, an external iron, which fixes into the boot, has a pad to press upon the great trochanter and can be firmly fixed to the thigh and leg, had better be used. It is not necessary in these young children to have a joint in the region of the knee. Without a joint the iron is more effective. Irons should be worn until, by treatment, the disease has been ended and the bones have again become firm. In neglected cases, where the bones are really hard and cannot be moulded by splinting, an osteotomy of the femur a short distance above the epiphyseal line becomes necessary.



Genu valgum.

Adolescent knock-knee is a condition which affects the lower end of the femur only. There is an irregularity of bone formation at the epiphyseal line. The shaft grows more quickly on the inner than on the outer side so that the epiphysis itself comes to lie obliquely on the lower end of the femur, pointing laterally as well as downwards. That there is no enlargement of the medial condyle of the femur can easily be demonstrated by flexing the knee joint when it will be found that the deviation disappears, whereas, of course, if the whole condyle were larger it would persist. With the lateral deviation of the tibia some displacement of the soft parts occurs. In extreme cases the popliteal artery itself will come to lie behind the lateral condyle, while the medial hamstrings occupy the intercondylar notch. The biceps

tendon will stand out strongly like a bow-string on the lateral side. The medial ligament is usually stretched and there may be a slight amount of fluid in the rather lax joint. A characteristic osteoma on the medial side of the tibia is frequently present. Very often there is flat foot at the same time.

Adolescent genu valgum occurs in children who are growing rather quickly and are of the clumsy, gawky type. They have outgrown their strength. Whether the disease is actually due to rickets or not, the diet of the patients should be corrected with this consideration in mind. In early cases it is sometimes sufficient to raise the inner borders of the soles and the heels of the boots in an attempt to throw the weight on the medial rather than on the lateral side of the knee joint. In advanced cases the femur must be divided in order to correct the deformity. There are two methods of carrying this out. One by inserting an osteotome on the medial side of the knee joint half an inch above the adductor tubercle and cutting the anterior three-quarters of the femur through in this situation and then breaking the rest. The other method is to saw the femur across an inch or two higher up by a saw inserted through an incision on the lateral side. The first operation is MacEwen's osteotomy. After it has been performed the limb is placed in a long posterior wooden splint with a foot-piece which reaches upwards to the glutaeal fold. Side splints may be applied in the region of the knee joint. The whole limb is slung in a cradle. It is important that the whole of the femur should not be divided with the osteotome and that the fracture should be completed manually. The reason for this is that by operating in this way some of the periosteum is left intact, which prevents the small lower fragment of the femur rotating backwards, by action of the gastrocnemius, and pressing on the popliteal artery and causing perhaps gangrene. The breaking of the posterior layer of the bone should always be carried out by bending the leg laterally. If it be bent medially there is a danger of stretching the lateral popliteal nerve over the sudden angle which is made, causing thereby a paralytic foot drop. The popliteal artery is very seldom damaged. A pad of fat intervenes between it and the posterior surface of the femur which, itself, should not be divided with the osteotome. Should such an accident occur, the artery should be tied.

Genu Varum (Bow-Legs)

Genu varum is a *rickety deformity which is described on page* 493.

Deformities of the Feet

Pes Planus

There are three arches in the foot: the longitudinal arch, the transverse arch in the front part of the foot in the region of the metatarsal bones, and a medial arch on the medial side of the foot seen most clearly when the two feet are placed with their medial borders in apposition.

Flat foot may be due to a variety of causes. It may occur as a result of paralysis of muscles (paralytic flat foot); it may occur as the result of an injury such as a fall on the feet (traumatic flat foot), or as the result of a prolonged strain on the foot as in people who have to do much standing (static flat foot).

Static Flat Foot.—This is the common form of the condition and is always due to a weakening of the muscles owing to overstrain. The actual flattening of the arch is preceded by a period during which a great deal of pain is complained of although the foot has retained its shape. This is the period of foot strain when no actual flattening has occurred. The pain is due to the brunt of the stress of standing falling upon the ligaments unsupported by the muscles. Four degrees are recognised. In the first degree the arch returns when the patient takes his weight off the foot. In the second degree the flatness persists when the weight is taken off the foot but the arch may be made to reappear if the individual stands on his toes. In the third degree of flat foot, the patient cannot, by his own muscles, restore the arch but this can be done by manipulation by the surgeon. In the fourth degree the foot is rigid. This rigid flat foot is again of two varieties. In the one the rigidity is due to adhesions in the small joints of the foot or to the contraction of ligaments and will give way before manipulation under an anaesthetic, whereas, in the other, the bones have altered in shape so that no manipulation, even under the deepest anaesthesia, can restore the foot to its former shape. Flat foot is seen particularly in adolescents who have grown quickly beyond their strength. It is seen in young people who have to stand for long hours and in individuals who are putting on weight in later life.

The first complaint of the patient is of pain which is worse on standing and relieved by taking the weight off the feet. The pain is felt in one or more of five places: on the medial side of the foot beneath the head of the astragalus, where it is due to the stretching of the inferior calcaneo-scaphoid ligament; on the outer side of the foot beneath the lateral malleolus, where the everted os calcis comes in contact with this bony prominence; on the dorsum of the foot, over

the heads of the metatarsal bones, due to the strain of the inferior metatarsal ligament; over the tuberosity of the os calcis on the plantar surface where the plantar fascia is attached; and, finally, in the calf from strain of the calf muscles. The deformity which comes on when the ligaments have stretched is one of eversion of the foot at the subastragalar joint and abduction at the mediotarsal joint. There is a prominence on the inner side of the foot where the head of the astragalus projects. If an imprint of the sole be made when the patient bears his weight on the foot it will be found that the medial border is in contact with the ground. This deformity of the foot is associated with a synovitis of some of the tarsal joints, párticularly the mediotarsal and subastragaloid joints, and may be accompanied by oedema of the foot. In some cases the synovitis passes on to an acute traumatic



Flat-foot.



Left: imprint of normal foot.
Right: imprint of flat foot.

arthritis when the foot is held rigidly by muscular spasm in the everted and abducted position. The tendon of the peroneus longus is seen to stand out strongly and attention has been directed particularly to this peroneal spasm; but if a careful examination is made, it will be found that all the muscles acting on the joint are in spasm at the same time. Such feet are very painful on any attempt at forced inversion. Dropping of the arches means that certain ligaments are stretched. These are particularly the inferior calcaneo-scaphoid ligament, the long and short plantar ligaments, the inferior transverse metatarsal ligament, and the plantar fascia. The shape of the foot is maintained normally, partly by muscular contraction and partly by ligaments. When the muscles become weak and are no longer able to maintain the arch of the foot, strain is thrown upon the ligaments, which are unable to withstand this continued force, stretch, allow the arches to become obliterated and, in doing so, give rise to pain.

In the treatment of static flat foot it is therefore important to do two things: restore the foot to its proper shape and maintain its position so that the stretched ligaments may shorten up; and to strengthen the muscles which act upon the foot. At the same time care should be taken that the individual walks with the toes pointing

straight forwards and not pointing outwards. The muscles which must be particularly strengthened are those in the calf and the small plantar muscles. Exercises have been devised particularly for exercising these small muscles, and they should not be omitted. With regard to the exercising of the calf muscles, the surgeon should take care that his exercises do not tire these muscles before the patient starts on his work if he has to persist with it, for this will only make matters worse. It is much better to begin by preventing the patient from following his occupation which has brought on the condition.

In the first degree of flat foot, exercises are all that is necessary. In the second degree, it is often a great help to recommend an arch support. This can be made to fit a plaster cast of the foot taken when the arch has been restored by manipulation. A good instrument-maker can beat out the support to its proper shape without the need for a cast. Some surgeons object to the use of arch supports on the score that the muscles are relieved of work which would strengthen them. This is obviously not a valid objection to supports, because no patient can maintain the erect position without throwing his muscles into contraction. Supports simply act as splints maintaining the arch so that the ligaments have an opportunity of contracting to their proper length. On the other hand there are certain surgeons who believe that, if the ligaments are sufficiently stretched, all pain will disappear and, if the muscles are strengthened, the arch can be restored. They point to the mobile supple feet of ballet dancers in support of this contention. According to them the proper treatment for beginning flat foot is forcible manipulation so as to stretch all the ligaments and, in fact, to flatten the foot, as much as it is possible to do, after which exercises are employed to strengthen the muscles. In the third degree of flat foot the rigidity is due to adhesions in the mediotarsal joint, or contraction of the ligaments on the outer shortened side of the foot, or in the acute cases, to spasm of the muscles acting on the mediotarsal joint. In these cases an anaesthetic should be given, the adhesions broken down by manipulation and the foot placed in an inverted adducted position and kept in that attitude by plaster of Paris bandage, extending from the tips of the toes, on the plantar surface, to the tubercle of the tibia. After 24 hours the patient should be encouraged to walk about in the plaster. This exercise is a very important factor in recovery. It prevents the muscles from wasting, which they would otherwise do if the patient were kept in bed in the plaster; and the weight of the body thrown downwards on the foot in the over-corrected position tends to increase the arch instead of flattening it.

After a fortnight the plaster is removed and the patient is allowed

to go about with an arch support. He also carries out remedial exercises. The shape of the shoes should be such that the patient can walk with his toes pointing straight forward. They should be a loose fit and have a perfectly straight inner border. For early cases in the first degree it is a help if the inner borders of the soles and heels are raised $\frac{3}{8}$ inch above the outer borders whilst the inner side of the heel is prolonged forwards for $1\frac{1}{2}$ inches to support the instep. The heel should not be lowered too much for women who are used to wearing high heels, for in them there may be some resulting contraction of the tendo Achillis which does not allow the heel to come comfortably to the ground when no shoes are worn, a condition of affairs which puts a great strain on the foot and the calf muscles and, in fact, is liable to cause flat foot.

In the rigid flat foot, due to alteration in the shapes of the bones, no treatment is indicated as the condition is nearly always painless.

Paralytic flat foot is referred to under deformities which occur as the result of paralysis.

Metatarsalgia

This is a condition of persistent pain in the anterior part of the foot which is increased by standing. If the foot is examined there will always be found a flattening of the anterior arch. The fourth metatarsal bone is depressed between the neighbouring metatarsals and it is thought that the pain is due to pressure upon the digital nerves which run on either side. The pain is increased by squeezing the heads of the metatarsal bones together, thereby causing further pressure upon the nerves. On the other hand, if a small pad be put under the heads of the metatarsal bones, and the front of the foot surrounded with a girdle of strapping, the pain is relieved. This, in fact, is the best treatment for metatarsalgia combined with exercises to strengthen the intrinsic muscles of the foot and the muscles of the calf. In inveterate cases excision of the head of the metatarsal bone through a dorsal incision sometimes becomes necessary.

Many years ago a neuroma at the site of pressure on the digital nerve was noticed and its excision led to relief of the pain. This observation has recently been confirmed and acted upon. The neuroma, apparently an inflammatory reaction to pressure, is usually in the digital nerve going to the cleft between the third and fourth toes and is situated at the level of the head of the metatarsal. It is removed by a small incision in the sole at this point. It brings about immediate relief. The falling of the anterior arch must still be corrected.

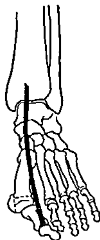
Spurs on the Os Calcis

Patients are sometimes seen complaining of pain on the under surface of the os calcis in whom an X-ray demonstrates ossification extending into the long plantar ligament, forming a spur. This condition is always secondary to some kind of flat foot, particularly the flat foot associated with gonorrhoea; hence the term gonorrhoeal exostosis of the os calcis is met with.

As a rule no surgical treatment beyond that for the accompanying flat foot is necessary but, in exceptional cases, the spur becomes so large that it has to be removed in order to relieve the pain. This is done through an incision on the outer side of the foot just above the sole.

Hallux Valgus

Hallux valgus is a condition in which the great toe is deviated laterally at the metatarso-phalangeal joint. It is a very common deformity of the foot and there seems to be an innate tendency for it to occur in certain families. There is no doubt that the appearance of this deformity is associated with improper methods of walking, particularly walking with the foot out-turned, and with the wearing of boots of which the medial border of the sole slopes forwards and laterally. The condition is really a subluxation of the affected joint, the lateral ligament becoming shortened whilst the medial ligament is stretched and an articular area on the inner side of the head of the metatarsal loses its contact with the phalanx. The projection of this head is liable to rub against the boot and become inflamed with the formation of an adventitious bursa in this situation. When this bursa is inflamed it is called a bunion. Chronic irritation actually leads to the formation of an exostosis on the medial side of the head of the metatarsal bone, which itself tends to make matters worse. The bursa may suppurate.



The bones in hallux valgus. The subluxation of the first phalanx, the exostosis of the first metatarsal and the distorting pull of the extensor tendon are shown. The second toe is a hammer toe.

Early cases are treated by the wearing of boots of which the medial border of the sole is sagittal in direction, a proper method of walking in which the toes point straight forwards instead of laterally, and the wearing of a small pad of wool or sponge rubber between the first and second toes. Pressure over the head of the metatarsal bone can be relieved by a disc of elephant plaster which has a hole in its centre.

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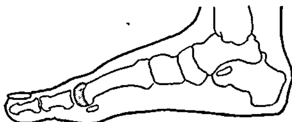
and becomes rigidly fixed (hallux flexus). At the same time, osteo-arthritic changes occur which affect not only the head of the meta-tarsal bone but the base of the first phalanx. In the early stages the condition is relieved by removing all strain from this joint when walking. This can be done by having fixed to the sole of the shoe a ¼-inch thick bar of leather which runs obliquely across the sole in the region of the necks of the metatarsal bones. In walking the patient carries his weight from his heel on to this bar and does not use his toes at all. The whole condition will usually subside, when treatment of the accompanying flat foot can be undertaken. Another method to give relief is to have a strip of steel incorporated into the sole of the boot along its medial side. This acts in the same way.

In long-standing cases of hallux flexus the rigidity may be due to adhesions in the joint which can be broken down by manipulation when the acute symptoms have subsided, or in older cases still the rigidity may be due to fixation by osteophytes. In these bad cases of hallux rigidus excision of the head of the metatarsal bone is also recommended, but the operation is not so certain to give a movable joint as it is in the case of hallux valgus; the reason for this is that hallux valgus is primarily a dislocation of the joint, whereas hallux rigidus is a primary arthritis of the joint in which both the opposing articular surfaces are diseased, thus making an ankylosis very easy, so that, even after excision of the head, the phalanx sometimes becomes adherent to the raw surface of the bone and movement still remains in abeyance.

Hammer Toe

Hammer toe is a deformity of the second toe in which there is hyperextension of the terminal interphalangeal joint, flexion of the first interphalangeal joint and an extension of the metatarsophalangeal joint. It is frequently associated with hallux valgus. The flexion of the interphalangeal joint becomes so acute that an actual subluxation occurs, and it is impossible to restore the normal position of the toe owing to the contraction of the plantar ligament and the plantar portions of the lateral ligaments. The projecting head of the bone is apt to press on the shoe and lead to the formation of a corn there, and sometimes underneath it a bursa which may become infected and suppurate. In cases which cause persistent trouble the first inter-phalangeal joint should be excised, the end of the first phalanx pointed and inserted into a hole made into the base of the second phalanx. This operation should not be done in the presence of inflammation of a bursa underneath the corn, which should be treated first by incision and, if necessary, fomentations.

When the deformity is very great only an operation will relieve the patient. Very many operations have been devised for this condition, but the simplest and most effective is the removal of the head of the first metatarsal bone. This is accomplished through an incision along the supero-medial border of the toe. There is no need to do anything to the bursa, though it may be dissected out, but, of course, no such operation should be undertaken while the bursa is inflamed. Any damage to the base of the first phalanx should be carefully guarded against. The results of this operation are very good. Some surgeons recommend removal of the base of the first phalanx rather than the head of the metatarsal bone, but as the base of the first phalanx is always healthy, and the pathological process affects the head of the metatarsal bone, this does not seem to be such a good procedure, though the published results show that there is very little difference in the measure of success obtained.



Hallux valgus. The part of the first phalanx which is removed in operative treatment.

Some persons are born with an abnormally wide angle between the shafts of the first and second metatarsals. The first digit is directed medially away from the others like a thumb. This deviation from the normal nearly always leads to a pronounced hallux valgus later in life. When a skiagram shows such a deformity the operation just described will not be sufficient. The exostosis if present should be chiselled off, and the lateral ligament of the joint divided to allow of reduction of the subluxation. Then an osteotomy of the shaft of the first metatarsal should be done in a direction pointing obliquely downwards and forwards. The anterior part of the metatarsal can be then swung round to correct the alignment. The foot must be put up in a plaster for a month but the patient may be allowed to walk in his plaster at the end of three weeks.

Hallux Rigidus

This is a condition of acute arthritis of the metatarso-phalangeal joint of the great toe. It is usually seen in adolescents or young adults and is, as a rule, associated with flat foot. It is attributed to repeated injuries of the joint in walking. Clinically, the joint is absolutely rigid, due to muscular spasm, and exquisitely tender to touch and painful when any attempt is made passively to extend the joint. If the condition is allowed to persist the straight great toe gradually flexes

Ingrowing Toe-nail

This is a condition due to pressure of the soft parts against the sides of the nail of the great toe, the result of crowding the toes together in a tight boot. The medial side of the nail is affected more than the other. The nail fold becomes red and swollen and comes to overlie the nail. There is very considerable pain, for, as the nail is forced against the soft parts, traumatic ulceration will occur under the fold, granulations will form here and often be seen protruding, whilst there is a sero-purulent discharge.

In the acute septic stage fomentations should be used but, in inveterate cases, the condition can only be relieved permanently by an operation. In this operation the side of the nail, together with its matrix, is removed by an elliptical incision and the soft parts sewn again to the nail. The result is a permanently narrowed nail which gives lasting relief.

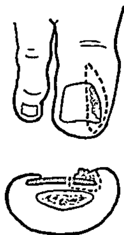


Diagram explaining the removal of a part of the nail with the nail bed for ingrowing toe-nail. The dotted line on the upper drawing represents the incision through the nail and nail bed. The lower drawing is a transverse section of the toe.

Onychogryphosis

This is an infection of the nail which becomes thickened and grows into a curved structure like the talon of an eagle. The underlying cause is not known but it usually appears in people past middle age. It may cause a good deal of distress by pressure upon the boot, which will force the nail against the soft parts and cause a disturbance similar to that seen in an ingrowing toe-nail. It is almost impossible to keep the growth of the nail in check by cutting or filing, and the only treatment that is at all effective is the removal of the hypertrophied nail and the whole of the matrix, great care being taken to remove the matrix from the depths of the nail groove. The raw area can be covered partly from the flaps and will soon epithelialise over. The patient never grows another nail but he is cured of his disease.

Subungual Exostosis

This is the formation of a cancellous osteoma on the dorsum of the last phalanx of a toe, nearly always the great toe. It raises the nail and causes pain by pressure on the boot. Sometimes actual

Corns (Clavus)

Corns are of two varieties: hard and soft. Hard corns are due to pressure. They are papillomata which, owing to pressure, grow into the corium rather than outwards. Soft corns are due to infection by the epidermophyton fungus.

Hard corns occur on places which are subjected to pressure of the boot, which may actually be due to a deformity like a hammer toe. Such corns will remain until the underlying deformity is remedied. In other cases comfortable boots should be prescribed and pressure on the corn relieved by small discs of adhesive felt plaster with central perforations. Corns can be kept down by paring with a knife after soaking in hot water, but old people with poor circulation should always be warned against this procedure as the cutting of a corn has frequently been the beginning of senile gangrene. A good way to get rid of corns is to cover them with some solid salicylic acid crystals kept in place with a piece of zinc oxide plaster. The plaster is left in position for 6 days. When it is removed the corn can usually be dug out with the greatest ease. When the bursa, which sometimes forms under a corn, suppurates, it should be drained by cutting away the overlying corn.

Epidermophytosis, the cause of soft corns, is a very common infection of the foot and very difficult to eradicate. In some countries there is a particularly high incidence among the population and it is apt to spread through the schools, infection taking place in the neighbourhood of swimming-baths particularly.

The fungus settles into the interdigital cleft between the fifth and fourth toes, sometimes in the next cleft, but not very often in the others. White soft thickened skin occurs in these situations. From time to time an inflammatory reaction spreads from these areas, perhaps on to the sole of the foot, and perhaps to the other toes, particularly in the neighbourhood of the grooves round the nails. The nails may be affected and become hard and brittle, and yellow in colour. Some people regard the condition as an incurable one, but it can always, by treatment, be kept localised to the cleft between the small and next toes. Very many remedies have been prescribed: painting with iodine, painting with carbolfuchsin, the application of Whitfield's ointment (20 grains of benzoic acid with 15 grains of salicylic acid in a paraffin basis). Particularly important is the drying of the intervals between the toes after bathing, the powdering of these clefts with some absorbent powder like talc and the cutting of the nails as short as possible.

tion is at all advanced, an open operation is necessary. Steindler's operation has proved very effective in many instances. Through an incision along the hinder part of the lateral border of the foot the plantar fascia and the small muscles attached to the os calcis are freed from their attachments to this bone. When this has been done, the other rigid structures in the foot will frequently give way to manipulation so that the arch is flattened and the soft tissues slide forwards on the os calcis and get new attachments. The foot is put up in plaster in a valgus position, in which plaster the patient is allowed to walk as soon as he can do so.

In adults the disability is usually due to pain which is felt from the excessive pressure on the heads of the metatarsal bones. In the milder cases this pressure can be relieved by fitting an arch support which will distribute the weight of the foot. At the same time, the hard skin over the metatarsal heads should be softened with a salicylic paste and scraped away. If this is ineffective, Steindler's operation may be carried out but, as a rule, in adults bony deformations have occurred to such a degree that no lessening of the arch is possible by manipulation. When the suffering is great it is sometimes necessary to carry out a subastragaloid and mediotarsal arthrodesis. The foot will be rigid but it will be painless.

An operation has been devised by Lambrinudi for the treatment of pes cavus which has given relief apparently whenever it has been tried. It consists in performing an arthrodesis of the interphalangeal joints of the medial four toes. This is a rather tedious operation and a special splint is required to keep the toes extended whilst the joints become ankylosed, but when it has been completed the long extensors act upon the second and third phalanges and, curiously enough, the heads of the metatarsal bones seem to be raised and the pain relieved. Cole's operation is the removal of a wedge of bone with its base upwards from the anterior part of the tarsus. It lies in front of the mediotarsal joint (in which lies the great advantage of the operation) and behind the bases of the metatarsals.

In less pronounced cases the same surgeon transplants the extensor longus hallucis and the four long extensors of the toes to the cuneiform bones. The interphalangeal joint of the hallux will need ankylosing because it has no short extensor. At the same time open plantar fasciotomy and stretching is usually done.

Talipes

Talipes is the name given to alterations in the position of the foot which cannot be corrected by the patient. If the foot is planti-flexed,

ulceration is caused. The condition is also met with in the fingers.

Treatment is to remove the nail and chisel away the exostosis. The nail matrix should be preserved as far as possible.

Pes Cavus

This deformity again may be acquired or congenital. The acquired form is due to paralysis of the extensors, and will be considered later. Congenital pes cavus is a most intractable deformity of the foot. The condition is due apparently to the disturbance of the relative rate of growth of the skeleton and the soft parts. The muscles and ligaments do not grow as fast as the bones, so the foot becomes bent up into a very pronounced arch whilst the ends of the toes are similarly approximated, the first phalanges being hyperextended and the second and third flexed. If this be the real explanation it can be understood that the condition may not become troublesome to the patient until some years after birth, in fact the commonest age for which surgical aid is sought is about 6 or 7 years. The disproportion between the growth of the two elements of the foot will naturally persist until growth ceases. This explains the very great tendency to relapse after the deformity has been rectified.

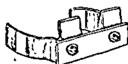

Pes Cavus.

The patients begin to complain of pain in the foot after walking and standing. If an imprint of the sole be made it will be found that the lateral border of the foot is no longer in contact with the floor as it is in the normal foot. The patient bears all his weight on the point of the heel and the heads of the metatarsal bones. Under the latter hard callosities appear. At the same time that the longitudinal arch is exaggerated the transverse arch of the foot is lowered so that the heads of the middle metatarsal bones project too low and the pressure callosities over them are very evident. The first interphalangeal joints, pressing against the boots, become painful and corns form over them. In the sole the plantar fascia can be felt to stand out as strong hard strand. This explanation of the cause of the deformity, namely, that it is a muscular dystrophy, is the most satisfactory, but it has also been held that it is due to a weakness of the long dorsi-flexors of the foot. It is difficult, however, to see how weakness of these muscles would lead to an acute dorsi-flexion of the metatarso-phalangeal joints.

The condition is extremely troublesome to treat because of the great tendency to relapse. In young children manipulation and stretching of the plantar fascia may be sufficient but, when the condi-

supposed that it is due to a deficiency of liquor amnii and pressure of the uterine walls on the feet of the foetus, but there is no definite evidence that there is such deficiency of liquor amnii in cases of talipes equino-varus. It would appear to be much more likely that this is again a disturbance of the relative growth of the muscles and the bones. In earlier intra-uterine life if the invertors of the foot do not grow at the same rate as the skeleton the foetal position of the foot would persist.

The treatment of talipes equino-varus should be begun as soon after birth as possible. Daily manipulation of the foot in the corrected position will frequently overcome the deformity but, where it is at all pronounced, the foot should be manipulated and then splinted in that apparatus devised by Denis Brown. In this splint the child is free to move its legs, and during flexion and extension the position of valgus is increased so that the muscles are not allowed to waste and there is a continuous tendency to correct the deformity. The manipulation should be completed at one sitting. Repeated attempts to redress the deformity lead to much scarring and contraction from the recurrent injury, so that success is not attained in this way. When the child grows older, boots should be fixed to the sole plates of the splints, which should lace the whole way up the front and should have no toecaps, thereby allowing the feet unobstructed growth. The child can be allowed to walk but during the night and during part of the day he should wear his apparatus. Children with congenital talipes require supervision until growth ceases.



Denis Brown's splint for talipes equino-varus.

In neglected cases or cases which show such strong tendency to deformity that such treatment is ineffective, an open operation will have to be performed. In this an incision is made on the medial side of the foot and all the contracted ligaments round the head of the astragalus and the attachments of the tibialis posticus, except that to the scaphoid bone, and the attachments of the small muscles to the os calcis are separated. This allows the subluxation at the mediotarsal joint to be remedied by forcible manipulation. When the foot has been placed in the corrected position it is encased in plaster which should reach above the knees in very young children but need only come up to the tubercle of the tibia in older children. Manipulation after this operation will have to be repeated at intervals.

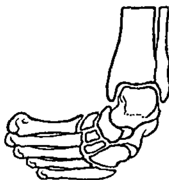
In still more neglected cases where the bones have become so deformed that no manipulation can alter the shape of the foot some operation on them will be required. There are two successful pro-

the condition is called talipes equinus. If it be dorsi-flexed, it is called talipes calcaneus. If it be turned medially, it is called talipes varus. If the foot be everted, the condition is called talipes valgus. The commonest deformity is a combination of inversion and planti-flexion, talipes equino-varus. The other common deformity is talipes calcaneo-valgus.

Talipes may be (1) congenital, (2) acquired or paralytic.

Congenital Talipes Equino-varus is the commonest of all these deformities. The foot is not only pointed in the equinus position but turned medially so that there is a characteristic crease across the sole. If the condition is not corrected in infancy the child will grow up and the deformity will increase in degree so that, in the end, he will walk about on the lateral borders of his feet, where great callosities and adventitious bursae form. The deformity is primarily a subluxation at the medio-tarsal joint so that the anterior part of the foot is rotated medially round the head of the astragalus. At the same time the os calcis is rotated medially under the same bone. The ligaments on the medial side of the foot become contracted, particularly the calcaneo-scaphoid. The ligaments on the sole of the foot, the plantar ligaments and the plantar fascia also become contracted, as does the posterior ligament of the ankle joint. The lateral calcaneo-scaphoid and dorsal astragalo-navicular ligaments are stretched. The invertors of the foot, that is, the tibialis posticus, the tibialis anticus and the gastrocnemius, are contracted. The long flexors of the toes are also shortened, whilst the peroneal muscles are lengthened. The chief alterations in the bones are seen in the astragalus. The broad surface of the head is carried medially on the medial side of the neck, and the head is conical in shape. The triangular upper articular surface of the astragalus may grow so that it is impossible to replace it between the malleoli of the tibia and fibula. The posterior part of the os calcis is poorly developed. There are no other very distinct changes in the bones except in the cuboid, which becomes adapted to the inverted position of the foot and is relatively larger.


Congenital talipes equino-varus.


Bones of the foot in congenital talipes equino-varus. Neck of astragalus deviated medially. Front part of foot swung medially at medio-tarsal joint exposing parts of articular surfaces of head of astragalus and of front of calcaneus.

The cause of talipes equino-varus is not known. It has been

there is the subsidence of the inflammatory reaction, which has been pressing upon the anterior horn cells and which is now gradually released; and secondly, there occurs a re-education of the muscles and nerve centres in which nerve cells in the neighbourhood, which have retained their vitality, gradually assume the power of controlling the muscles, partial though it may be. This re-education is extremely important and occurs very slowly. Whilst massage may improve the circulation through the muscles and help their local recovery, the most important factor is their voluntary contraction, so that the significant function of the masseuse is to urge the child on to make voluntary efforts to move his joints. A skilled masseuse will do this by turning the exercises into a game. Electrical stimulation of muscles is not worth the disturbance and fright to which it subjects the patient. There is another principle which must be borne in mind, and that is that no paralysed muscle should ever be allowed to be stretched, for a paralysed muscle in tension cannot recover its function. Therefore the correct attitude of the limb should be maintained through the whole series of exercises. The bed treatment should last for about one year. Although long before this it is possible to get the patient up, experience has shown that the ultimate recovery is lessened by doing so. When the child is allowed on his feet, some retentive apparatus should be fitted to prevent his extremities falling into deformed attitudes. These appliances should be as light as possible; for instance, in paralysis of the invertors of the foot it should consist of a light sole-plate and a lateral iron going up to a calf band. A shoe can be worn over the sole-plate. In paralysis of the evertors of the foot the upright should be on the medial side. The angle between the foot-plate and upright should always be an acute angle. This governs the side on which the upright should be. If the quadriceps is weak, some form of caliper splint is needed but it should be the lightest possible. Fortunately much of the paralysis, as a rule, clears up, but very serious deformities may remain, and the most serious are those where the back muscles are paralysed and a most extreme form of scoliosis results.

When the period of recovery is at an end in two years' time there should be no deformities of the limbs if the case has been looked after satisfactorily, but if there are deformities such as equinus or equino-varus, or contraction of the knee or hip, these attitudes should be corrected. They are very much more easy to remedy than congenital deformities. The muscles which are particularly likely to be affected in the lower limb are the extensors of the knee and the dorsi-flexors and evertors of the foot. Deformities of the foot can usually be corrected by simple manipulation and the application of a plaster

cedures—(1) excision of a wedge of bone from the supero-lateral aspect of the tarsus; (2) excision of the astragalus with backward displacement of the foot. In these very neglected cases it is sometimes necessary to divide the inferior interosseous tibio-fibular ligaments in order to allow the astragalus to enter between the malleoli, and, in these cases also, lengthening of the tendo Achillis may be necessary.

Paralytic Deformities

Infantile Paralysis

This disease is due to a virus which enters the body, as a rule, through the nasal mucosa. It probably begins as a septicaemia but the organism has an elective affinity for the central nervous system (neurotrophic). In this system there is, at first, a mild meningitis which affects the dorsal root ganglia and so gives rise to pain. Later, the changes of hyperaemia and haemorrhage occur in the spinal cord itself, and particularly round the anterior horns. The acute condition lasts for a number of weeks, when the inflammatory changes gradually subside and are replaced by the formation of scar tissue (neurogliosis), which causes permanent damage by pressure on a number of anterior horn cells with resulting paralyses. The general septicaemia at the beginning manifests itself by a high temperature, vomiting, and perhaps diarrhoea or respiratory symptoms. The meningeal changes are evidenced by irritability, pains in the muscles and tenderness. The paralysis comes on within 24 hours. It may be, according to the severity of the case, very widespread or so slight in nature that it is overlooked. There is a lymphocytosis and the cerebrospinal fluid contains an increased number of mononuclear cells. The acute stage lasts for 6 or 7 weeks and then a stage of gradual recovery occurs, the paralysis clearing up to a greater or lesser extent. This recovery is continued for about two years, when the case enters into a stationary stage.

In the treatment of infantile paralysis it is extremely important, during the early part of the disease, to prevent deformities occurring. Light splints should be applied to the legs and feet to prevent foot-drop but no local treatment beyond this should be carried out as the muscles are tender and any manipulation is likely to increase the inflammatory reaction in the posterior root cells. During this acute stage the patient receives symptomatic medical treatment only. As soon as the sensitiveness of the muscles and pain have disappeared, and recovery begins, measures should be taken to assist the return of muscular power. This return of power is due to two factors. First,

there is the subsidence of the inflammatory reaction, which has been pressing upon the anterior horn cells and which is now gradually released; and secondly, there occurs a re-education of the muscles and nerve centres in which nerve cells in the neighbourhood, which have retained their vitality, gradually assume the power of controlling the muscles, partial though it may be. This re-education is extremely important and occurs very slowly. Whilst massage may improve the circulation through the muscles and help their local recovery, the most important factor is their voluntary contraction, so that the significant function of the masseuse is to urge the child on to make voluntary efforts to move his joints. A skilled masseuse will do this by turning the exercises into a game. Electrical stimulation of muscles is not worth the disturbance and fright to which it subjects the patient. There is another principle which must be borne in mind, and that is that no paralysed muscle should ever be allowed to be stretched, for a paralysed muscle in tension cannot recover its function. Therefore the correct attitude of the limb should be maintained through the whole series of exercises. The bed treatment should last for about one year. Although long before this it is possible to get the patient up, experience has shown that the ultimate recovery is lessened by doing so. When the child is allowed on his feet, some retentive apparatus should be fitted to prevent his extremities falling into deformed attitudes. These appliances should be as light as possible; for instance, in paralysis of the invertors of the foot it should consist of a light sole-plate and a lateral iron going up to a calf band. A shoe can be worn over the sole-plate. In paralysis of the evertors of the foot the upright should be on the medial side. The angle between the foot-plate and upright should always be an acute angle. This governs the side on which the upright should be. If the quadriceps is weak, some form of caliper splint is needed but it should be the lightest possible. Fortunately much of the paralysis, as a rule, clears up, but very serious deformities may remain, and the most serious are those where the back muscles are paralysed and a most extreme form of scoliosis results.

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however, fixation of the shoulder joint may be desirable.

Trophic disturbances are sometimes very pronounced in infantile paralysis. The limbs are cold and blue and the patient suffers from very severe chilblains in the winter. Curiously enough, there may be a great thickening of the subcutaneous tissues so that the limb is large and blue. The circulation through these limbs can be improved by removing the sympathetic ganglia, and the patient's life made more tolerable.

Spastic Paralysis

Spastic paralysis dates from birth. It may be due to an injury to the brain at birth from haemorrhage, but more cases are due to incomplete development of the motor cortex. As this is an expression of a general weakness of the brain it is not surprising that these children are frequently intellectually dull, and this deficiency renders treatment in many cases extremely difficult. The paralysis, being due to a defect in the motor cortex, is a spastic paralysis accompanied by exaggerated deep reflexes. It is most common for one arm and one leg to be affected (hemiplegia), but both lower extremities may be affected alone (paraplegia), or all four limbs (diplegia), or a single extremity (monoplegia). At the beginning the infant may suffer from convulsions. The most obvious sign of the disease is muscular rigidity. The child is late in walking and, when he attempts to do so, makes awkward, jerky, difficultly controlled movements. When the lower limbs are affected the knee jerks are exaggerated and Babinski's sign is positive. As the child grows, characteristic attitudes are assumed. The hips are flexed and adducted and rotated medially, the knees are flexed, and the feet usually go into an attitude of equinovarus. If the child grows up without any correction being made, he may ultimately have scissor-leg progression. When an attempt is made to correct the deformity, the resistance of the contracted muscles is very appreciable. The limbs are wasted, but not to the same degree as in infantile paralysis, and the muscles feel firm. If one leg is affected it usually shows inhibition of growth.

A great deal of recovery takes place in early infancy. If, in a newly born child, there is paralysis with cyanosis and persistent asphyxia, accompanied by fits with confirmatory neurological signs, the child's skull should be opened, the clot removed and the bleeding stopped, but the results of surgical treatment are, on the whole, disappointing. As in infantile paralysis, deformities should be prevented from occurring by manipulations, exercises and splinting. As the child grows up, muscular education should be taken in hand. The operative treatment in spastic paralysis is difficult because the co-

bandage. Very bad flexion deformity of the knee is corrected by applying a plaster case from the toes to the groins, dividing it for two-thirds of its circumference round the back of the knee and inserting wedges of gradually increasing thickness in the slit. Flexion deformity of the hip can usually be corrected by weight traction.

It is only when all chance of spontaneous recovery has gone that operative measures should be considered. These procedures consist in tendon transplantation and stabilising operations on the joints. Tendon transplantation is the separation of a tendon from its insertion and its transference to another site. For instance, in talipes equino-valgus, the peroneus longus may be transferred to the medial side of the foot in order to correct the eversion, or the tibialis anticus may be transferred to the lateral side of the foot in order to correct inversion. In tendon transplantation very secure junction between the tendon and the bone must be made and this is usually done by drilling a hole in the bone and threading the tendon through it. There are not many cases in which tendon transplantation can be successful. The difficulty is not in the operative procedure but in the training which must take place in the patient's brain after the operation. It is difficult for him to learn to use a hamstring muscle for extending the knee should one of these muscles be transferred into the patella when the quadriceps is paralysed, so that such operations in which flexors are transferred into extensors, and so on, have been given up. The muscle which is transferred must belong to a group of muscles which acts in the ordinary movements of the joint which it is desired to restore. In the case of the knee joint where the quadriceps is very extensively paralysed, it is possible to suture the ilio-tibial band which is pulled upon by the glutaeus maximus and the tensor fasciae femoris to the outer side of the patella, and the gracilis to the inner side. By this means enough extension power may be restored to enable the patient to go about without there being the necessity for a splint to keep his knee rigid. Where the foot is a flail foot from very extensive paralysis of the muscles which move it, it can be stabilised by performing an arthrodesis of the subastragaloid, the astragalo-scaphoid and calcaneo-cuboid joints. As a rule it is better to leave the ankle joint mobile. With this mediotarsal arthrodesis it is frequently possible for the patient to get about without wearing an unsightly instrument on his leg. The knee joint should very seldom be ankylosed. A caliper splint with a joint at the knee, which can be made rigid at will, is far more convenient. Occasionally it is right to perform an arthrodesis of the hip joint.

Paralysis of the upper limb is very much less common and the cases in which operative measures are required are few. Here,

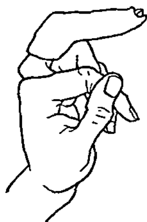
CHAPTER XLVI

THE HAND

Injuries to Tendons

Subcutaneous Injuries

The common injury is the tearing of an extensor tendon at its insertion into the terminal phalanx of the finger. This is caused by a blow on the point of the finger when it is nearly fully extended; for instance it may occur in attempting to catch a cricket ball. There are swelling and tenderness on the dorsum of the finger at the tendon's insertion and loss of power to get the finger straight. If treatment is carried out at once a good result can always be obtained. The joint should be hyperextended and kept in this position for at least a month by a light plaster of Paris casing. The proximal interphalangeal joint must be flexed because this relaxes the distal part of the tendon.



Plaster of Paris splint for avulsion of the extensor tendon from the terminal phalanx.

In neglected cases treatment is very difficult. Splinting should always be tried at first, but is likely to fail. The difficulty in an open operation is to obtain sufficient tendon to suture to the phalanx and to keep it taut. The operation is carried out by making a lateral incision on the back of the finger, turning aside the flap, and drilling the last phalanx transversely so that the tendon can be fixed directly to the bone. The deformity, when it has not been corrected, is sometimes referred to as mallet-finger.

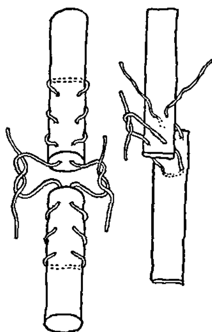
Incised Wounds of Tendons

Tendons are more frequently divided in the hand or wrist than in any other part of the body. The injuries result from accidents with knives or broken glass vessels or from thrusting the hand through a

operation of the patient is not very good. Tendon lengthening may be required for contracted muscles as, for example, contraction of the tendo Achillis, and sometimes muscles are divided as, for instance, the adductors when there is great adduction, or the pronator radii teres for pronation spasm. Another line of attack is the division, or partial division, of nerves. A good example of this is the division of the obturator nerve to abolish adductor spasm. If the obturator nerve is divided, it paralyses all the adductors except the adductor magnus, which has a double nerve-supply from the obturator and the sciatic. For talipes equinus the branches to the gastrocnemius or all the medial popliteal nerve may be divided. After the correction of deformities by tendon lengthenings and manipulations, plaster of Paris casts are used to maintain the position.

tendon very unresistant to infection. When infection takes place after a tendon repair, the inflammatory process may spread widely up the tendon sheath and cause great havoc in the hand, so that a rule must be made never to perform a primary suture in the hand or wrist when the wound has been grossly contaminated or even when, although it is a comparatively clean wound, more than five hours have elapsed since it was incurred. The search for the upper end of the tendon will often mean separate incisions in which infection, if present, will necessarily be implanted. The prognosis for movement after secondary suture is very much better. In suturing divided tendons of the hand general anaesthesia should always be employed and the operation should be done in a bloodless field brought about by the use of a blood-pressure apparatus round the upper arm inflated to a pressure of 220 mm. of mercury. The flat tendons on the dorsum of the hand can be joined up by overlapping them and the use of a very simple mattress suture but, where the tendons are circular in cross section, they should be joined by the method described above. In the palm of the hand it is better to make a transverse, rather than a longitudinal, incision. In the bloodless field the digital nerves, which lie just under the palmar fascia, can be easily avoided. The upper end of the divided tendon is sometimes difficult to find and a separate incision may be necessary above the wrist joint in order to discover it. It is sometimes helpful to inject novocaine and adrenalin into the muscle belly. This causes relaxation of the muscle fibres when, by a stroking movement, the tendon can often be pushed down towards the palmar wound, when the junction of the two ends can be effected. When the flexor tendons going to the fingers are divided in the region of the fibrous sheaths, the outlook for movement is exceedingly poor as adhesion to the surrounding parts nearly always takes place. The best results occur in the case of division of the flexor longus pollicis in the thumb, but, here, conditions are a little more favourable because there is only one instead of two tendons in the sheath concerned. In the case of the fingers, even though both superficial and deep tendons are sutured, they are likely to become adherent to each other, when the particular movement brought about by the flexor profundus will inevitably be lost. The finger can be voluntarily bent at the first interphalangeal joint but the terminal phalanx will remain extended. It is therefore recommended that the flexor sublimis tendon should be sacrificed, the peripheral end should be removed and the central end sutured higher up to the profundus tendon. This will allow more room for the play of the profundus tendon but, at the same time, it creates more raw areas in which adhesions form. The incision for exposing tendons in the flexor sheaths is best made down one side of

pane of glass. The diagnosis of the injury is usually quite simple if care is taken to test the various movements of the several muscles. The distal end of the tendon can usually be seen in the wound but the proximal end retracts. The treatment of divided tendons is not *always a simple matter. Tendons* are composed of bands of white fibrous tissue and they have a very poor blood-supply, so that repair in a tendon is tardy in beginning and slow to proceed. Tendons are either surrounded by synovial sheaths containing a lubricating fluid or, where sheaths are absent, by a very loose connective tissue which allows of free movement. When a tendon is divided repair proceeds at first from the surrounding tissues, whether it be a sheath or this loose tissue which is called the paratenon. These surrounding *tissues at first form a mass of granulations which fixes the two ends* of the tendon together and grow in between the severed ends. It is not until at least a week has elapsed that vessels grow out from the ends of the tendon and repair begins to take place within these structures themselves. Only after 3 or 4 weeks is there fibrous tissue joining the two ends. As soon as the tendon has repaired, the surrounding granulations tend to disappear and to be changed into the loose paratenon tissue which allows movement. In the case of the dorsal tendons of the hand, this nearly always occurs in a satisfactory manner but, where the tendons run through fibrous tunnels as they do on the flexor surfaces of the fingers, the surrounding granulations may organise, form adhesions which fix the tendons and *prevent any* movement from returning. In suturing tendon ends together it will be found that ordinary sutures are ineffective because they so easily pull out from between the *longitudinally running* bundles of white fibres. Hence, in sewing tendons a special stitch must be employed. It is also one of the occasions in surgery where silk is very *much preferable* to catgut, because silk sets up less surrounding inflammatory reaction and so is less likely to lead to adhesions. *It is also* clear that as repair is so slow the suture material must be one that lasts at least several weeks. Another great difficulty about tendon suture is also dependent upon the poor blood-supply which makes the



Method of suturing tendons. Round tendons are brought end to end: *flat tendons are overlapped with* simple mattress sutures.

growing from the sheath itself. It may be due to a chronic tenovaginitis.

It is easily remedied by removal of the fibroma in one or other of these situations.

Foreign Bodies in the Hand

A fairly common accident is the penetration into the hand of a piece of a needle or a piece of glass. Very often the foreign body goes far away from the wound and the wound heals without, perhaps, the patient being aware that anything has entered his flesh. Soon, however, a tender point is likely to appear, and if it is near the surface there will be a small hard mass which is a fibrous capsule round the body. It is not always easy to find the foreign body in the hand and particularly if it is not opaque to X-rays, a splinter of wood or a small piece of glass for instance, that is, if the glass does not happen to be opaque to X-rays. If it is a metallic foreign body X-ray plates should be taken accurately in two directions at right angles. In the hand itself the bones are so small that the position of the body can be very precisely localised anatomically and, knowing the situation of the foreign body, it is nearly always possible to plan an operation which gives easy access to it, without injuring any important structure. The operation should be done in a bloodless field effected by a blood-pressure apparatus round the arm and under general anaesthesia, and extreme care must be taken not to injure one of the digital nerves, thereby causing crippling anaesthesia of the side of the finger. Incisions, as a rule, are made longitudinally. When the needle is in the thenar eminence the incision should run parallel with the lateral border of the first metacarpal bone and the space between the superficial and deep layers of muscle in this situation entered. With the finger in this space it is usually possible to feel the foreign body either in front or behind according to the indication given by the X-ray. In similar manner foreign bodies in the hypothenar eminence are approached from the ulnar side. In the case of the wrist, or above the wrist in the forearm, it is not so easy anatomically to fix the exact position of a foreign body. Here the skin should be marked on the lateral and antero-posterior aspects in the X-ray room on screening the foreign body, and the indicated area approached. It is always better, if possible, to remove needles away from the X-ray room because asepsis can, as a rule, be more carefully preserved, but, rather than cause needless anatomical damage or run the risk of contamination from a prolonged operation, a foreign body should be removed under observation with the X-rays.

the finger. It may run transversely at the terminal crease in order to get at the *insertion of the flexor* profundus at the last phalanx. If, with the wrist extended, the central end of the profundus tendon reaches the first interphalangeal joint, then, with the wrist and finger flexed, it can be made to reach the terminal phalanx of the finger. In such a case the peripheral part of the tendon is sacrificed; by means of an eyed probe carrying a loop of silk, the central end of the tendon, which has been exposed by a transverse incision in the palm, is threaded through the flexor sheath and sutured to the bone of the terminal phalanx. It seems better to open the fibrous sheaths freely except at two places which are opposite the middle of the first and second phalanges, so as to leave pulleys over which the tendon can run. Only by this free opening is it possible to remove the end of the flexor sublimis and divide such adhesions as are present. The fibrous sheath need not be sewn up. It is better removed except for the above-mentioned pulleys.

After repair the hand should be fixed in the flexed position by a plaster of Paris bandage and no attempt at movement made for 7 days. After this, voluntary movements must be carried out. These movements may be fairly free at first but in 3 or 6 weeks' time the finger will appear quite stiff. In favourable cases this stiffness gradually passes off so that a good deal of movement may have returned at the end of a year. This return of movement obviously depends upon the disappearance of the tissue formed from the granulations which come from the sheath and which fix the tendon to the surrounding parts. There is another difficulty in restoring movement and it is an obscure *alteration in the innervation of the muscles* which cause the movement, or rather in the disturbance in the mechanism by which impulses are conveyed to them. There appears to be an inhibition such as occurs in the quadriceps muscle after operations upon the knee joint. The patient is quite unable to make voluntary movements which are so necessary to restore function.

Whilst, in the case of an extensor tendon, 80 or 90 per cent of good results are to be expected from a properly executed tendon suture, in the case of the flexor tendons *in the regions of the finger*, 80 per cent of failures is the rule.

TRIGGER-FINGER

In this condition the patient has some obstruction to the extension of the finger when it is flexed. When he succeeds in getting it straight it goes with a jerk. This derangement is due either to a fibroma in the tendon *at the proximal end of the sheath*, or a fibroma

growing from the sheath itself. It may be due to a chronic tenovaginitis.

It is easily remedied by removal of the fibroma in one or other of these situations.

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The best method is to thrust a needle or a pointed instrument into the wound until it can be seen to move the foreign body and to coincide with it. It should be left in position and the operation completed in the light.

Foreign bodies in other parts of the body, in the sole of the foot, in the thigh, in the buttock, are sometimes extremely difficult to find and are best done as a routine under observation with the X-rays.

Stenosing Tenosynovitis

This is a condition which affects the extensor ossis metacarpi pollicis and the extensor primi internodii pollicis tendons just below the styloid process of the radius. There are pain on strong abduction of the thumb and a swelling over the styloid process of the radius. If the thumb be grasped and quickly abducted, pain will be caused.

This disability is due to a thickening of the tendon sheath which forms a constriction. Relief is immediately brought about by operative division of the fibrous constricting sheath.

Ganglion

Ganglion is a lump which occurs in the sheath of a tendon or in the fibrous capsule of a joint which is the result of repeated small strains, and is usually seen in the region of the wrist. All ganglia, however, do not occur in this situation; they are also found on the tendons in the neighbourhood of the knee or ankle joints.

The ganglion itself is a cavity containing a glairy fluid. It is surrounded by the laminated connective tissue sheath which also shows areas of the same mucoid degeneration. The true pathology of a ganglion is not certainly known. It is not a protrusion of synovial membrane but would almost appear to be a fibroma in which myxoedematous degeneration has taken place. It is seen typically in the flexor carpi radialis tendon and is also very common on the back of the wrist. Ganglia are rounded, tense swellings which cause a considerable amount of disability and weakness in the hand. Curiously enough they sometimes suddenly disappear, apparently from spontaneous rupture of their walls and dissemination of their contents into the surrounding tissue. This natural cure can sometimes be imitated effectively by rupturing the ganglion subcutaneously by pressure. However, when caused to disappear in this way the ganglion is liable to return. There are two other methods of treatment: one by evacuation and injection of some irritant fluid, and the other by excision. Five per cent sodium morrhuate can be used for the first

under local anaesthesia. A large needle is thrust into the ganglion, the glairy fluid expressed and about 0·5 c.c. of the fluid injected. An inflammatory reaction supervenes and the ganglion is often cured.

In excising ganglia a general anaesthesia should always be employed because the ganglion may take its origin from the capsule of one of the small joints of the carpus, in a situation which a local anaesthetic may not reach. Under these circumstances excision is likely to be incomplete and recurrence will happen. The whole of the ganglion must be removed or it will certainly come again.

Tumours of the Hand

The following swellings are met with in the hand and wrist:

Ganglia.	Osteomata.
Implantation Dermoids.	Chondromata.
Xanthomata.	Simple Bone Cysts.
Fibromata.	Osteoclastomata.
Lipomata.	*Melanomata.*
Glomus Tumours.	Carcinomata.
Telangiectatic Granulomata.	

Ganglia are described on page 652.

Implantation Dermoids

These are small cystic swellings which are found in adults, usually on the fingers. They very often follow a penetrating injury such as a needle-prick or other accident which forces living epithelial cells into the subcutaneous tissue. Hence they are found in seamstresses. There are, however, a number of examples on record which have occurred as the result of blunt force. In such cases it is supposed that the force causes subcutaneous rupture of a sweat or sebaceous gland, the epithelium becomes separated and grows out into the cyst. These tumours are always small spherical swellings lying beneath the skin and obviously cystic. The treatment is excision.

Xanthoma

Xanthomata are tumours which grow from the connective tissue forming fibrous tendon sheaths, ligaments or other fascial layers. They form firm nodular masses most frequently on the palmar surfaces of the fingers or thumb, though they also occur in front of the wrist, where they simulate very strongly tuberculous tenosynovitis. The tumour is made up of yellowish or brownish lobules of tissue,

The best method is to thrust a needle or a pointed instrument into the wound until it can be seen to move the foreign body and to coincide with it. It should be left in position and the operation completed in the light.

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They are pedunculated or sessile, rounded, red, granular tumours, ulcerated on the surface, exuding pus. The exact pathology is not known, but if a section is taken it is seen that there is an angiomatous mass over which there lies a layer of granulation tissue infiltrated with leucocytes. They may be regarded as infected angiomata.

The treatment is excision but they recur unless removal is complete.

Osteoma

Cartilaginous osteomata sometimes grow from the phalanges, though rarely, and very occasionally form under the nail, where they resemble the subungual exostosis found in the great toe. They are treated as the similar tumour in the foot.

Chondroma

Chondromata grow in the substance of the metacarpals or phalanges where they form slowly growing swellings which gradually expand the bone and reach the surface. Chondromata usually occur in children and are very apt to be multiple. They should always be removed as early as possible.

The tumour is exposed, removed, the cavity scraped, the walls crushed together or, if there is much defect left, supported by a graft taken from the tibia. Excellent results from such grafts may be obtained even when only a mere shell of the phalanx remains. Chondromata, if allowed to remain, reach a considerable size later in life and may undergo sarcomatous change. If a finger is rendered useless by the size of the tumour or interference with the function of the tendons, it should be amputated.

Simple Bone Cysts

Simple cysts are sometimes met with in the phalanges where they form swellings which, clinically and radiologically, often resemble enchondromata. As a rule they are not an expression of a general fibrocystic disease of the skeleton associated with hyperparathyroidism.

They are treated by evacuating the cyst, scraping its wall, painting it with pure carbolic acid and crushing the sides together or, if necessary, inserting a bone graft.

Giant-Celled Tumours

Osteoclastomata are rather rare tumours which form in the metacarpals or phalanges. They are treated in the same way as benign bone cysts.

bound together by fibrous septa. They spread along the tendon sheaths and may actually penetrate the phalanges. Microscopically, they contain a number of giant cells; hence they have been called myelomata of tendon sheaths. They are quite benign and only need careful local removal.

Fibroma

Fibromata occur in the fingers and palm growing from tendon sheaths or the palmar fascia. Some of them grow from the deeper layers of the skin itself. They are hard in consistency. When they grow in the tendon sheaths or in the tendons they give rise to the condition known as trigger-finger (see page 650).

Lipoma

Lipomata sometimes grow under the palmar fascia between the tendons or between the muscles of the thenar or hypothenar eminence. They form soft fluctuating swellings whose nature is often obscure before they are exposed for their operative removal. This may present some difficulties as the lipoma is apt to have a number of branches which extend between the nerves and vessels of the palm and even between the bones towards the dorsum, a very similar condition to that which is found in the supraclavicular lipomata of the neck.

Glomus Tumours

Glomus tumours are little rounded structures which look like angiomata and which form particularly beneath the nail, where they cause attacks of pain which may become very severe. All that can be seen is a bluish spot or nodule beneath the nail, pressure on which causes pain. The tumour in growing may cause a depression in the underlying phalanx.

Pain is relieved by removing the nail, but it will recur as soon as the nail re-forms, so the only effective treatment is the removal of the tumour. These glomus tumours are regarded as hypertrophied neuro-myoarterial bodies described by Masson. They are really normal structures, being small arteriovenous anastomoses surrounded by muscle fibres and abundantly supplied with nerves. Their function appears to be the control of the temperature and circulation of the extremities.

Telangiectatic Granulomata

These are small tumours which are seen in the hand and are usually looked upon as granulomata, the result of pyogenic infection.

B. Infections of the Cellular Tissues of the Hand:
- (a) Commissural.
- (b) Median.
- (c) Thenar.
- (d) Hypothenar.
- (e) Dorsal.

Nearly all infections are due to local implantation of organisms when the resistance of the body is at a low ebb. Only exceptionally is the infection metastatic, as in some cases of suppurative arthritis of the interphalangeal joints and of acute osteitis in infants. Very often infection gets admission by way of a prick with a needle, thorn, splinter or other foreign body. Such a wound is not necessary as organisms can enter the orifices of the sweat glands. This is a very common method of infection in the case of the pulp of the finger, as can be understood when it is remembered that it is the pulp of the fingers that comes into contact with everything we grasp.

A. *Infections of the Fingers*

Subcuticular and Subungual Panaris

Subcuticular panaris is a comparatively mild affection. It occurs especially in children. It does not cause much pain and usually little constitutional disturbance. It is characterised by the formation of purulent blisters. When the overlying cuticle is removed the condition soon clears up. No anaesthetic is required for this, as the little operation is quite painless.

Paronychial Panaris

Paronychial panaris is evidenced by a redness and soreness beside the nail. The nail fold swells up and there is some oedema of the skin on the dorsum of the terminal phalanx. Soon a little purulent discharge oozes from under the nail fold. The infection is very apt to extend round the base of the nail and get under it. If it is allowed to remain here the matrix may be in part destroyed and the nail be permanently deformed. Therefore operation should not be delayed. Two vertical incisions are made running upwards from the nail, and the flap outlined turned upwards. The nail is then cut away as far as the pus extends. It is a great advantage to leave the distal part of the nail if it is possible, for much pain will be saved during the first


The operation for paronychia.

Melanoma

A peculiar form of melanoma grows beneath the nail and has been designated melanotic whitlow. There is usually a history of injury and then the formation of a tumour which looks like a mole and which may remain unchanged for many years. After a time it assumes a new growth, ulcerates and forms a black fungating tumour beneath the nail. The thumb is more often affected than the fingers. There are secondary growths in the axillary glands.

Treatment is amputation of the digit with a clearance of the axillary space. The ultimate prognosis is bad.

Carcinoma

Carcinoma of the hand grows typically on the dorsum, and is seen more especially in workers subjected to the chemical irritation of tar, paraffin, alkalies or sometimes of paint. It also results from exposure to X-rays or radium. A kind of eczematous condition in all these cases precedes the formation of a definite carcinoma, then a wart forms which may be present for years and usually becomes fissured. Ultimately the carcinoma develops. These carcinomata are fortunately not of a very malignant nature and a local removal very frequently suffices for their cure. It is not necessary to clear out the axillary glands unless they are palpably enlarged.

If the tumour is of any size and a large area is affected, a grafting operation must be done. A Tiersch graft is not suitable in this situation; neither is a Wolfe graft, because after removal the dorsal tendons are exposed and for their free movement there should be some fat interposed between the tendon and skin. The most satisfactory covering is a pedicle graft taken from the abdomen.

Infections of the Hand

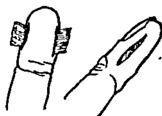
These may be classified as follows:

A. Infections of the Fingers:

1. Panaris (Panaritium, Whitlow):
   (a) Subcuticular.
   (b) Paronychial.
   (c) Subungual.
   (d) Subcutaneous.
   (e) Thecal.
   (f) Osteal.
2. Arthritis.

emphasised too strongly that a too precipitate incision of an infected finger may be more serious than too great delay; for the latter is associated with local consequences but the former may cost the patient his life. The type of infection accompanied with lymphangitis is seen especially in infections obtained in the operating or post-mortem rooms. Very often the local inflammation remains minimal in amount and actually may not need incision.

Operation for pulp infections takes place under local anaesthesia with a tourniquet round the base of the finger, or under general anaesthesia. With the latter a tourniquet is advisable as it allows of careful work in a bloodless field. An incision is made on each side, the margins held open, so that the necrotic tissue can be cut away, and a piece of thin rubber tissue passed through from side to side. The first dressing may be of vaselined gauze but boracic fomentations are more comfortable subsequently and are more effective, as they do not tend to lock up the discharge. If the finger becomes too macerated a dry dressing may be used for a few hours. Baths for septic fingers should not be used. They are likely to introduce added infection and, by causing the tissues to swell up and become macerated, interfere with drainage. The drain can be removed in about 3 days. The flap incision which runs over the top of the finger leaves a deformed finger-tip and a scar where the most delicate sensation is required. It should not be employed.



The operation for infection of the pulp.

Panaris of the second phalanx is much less common. It is treated by an incision on each side just where the dorsal skin differentiates itself from that of the palmar surface. A piece of rubber tissue can be passed across the finger from one incision to the other to act as a drain. In all these whitlows systemic penicillin should be given.

Neither is panaris of the first phalanx common. It forms a hard, tender red swelling in front of the first phalanx, usually to one side, and has a great tendency to spread to the corresponding commissure between the fingers, so that there is swelling on the dorsum of the hand as well. The incision in this case should be triradiate. One incision goes along the lateral border of the first phalanx, the other two run from the upper extremity of this: one on the dorsum and the other on the palm to drain the commissural area of spread.

few post-operative days. The best dressing after removal of the nail is vaseline gauze. The operation can be done under general anaesthesia or by anaesthetising the digital nerves at the root of the finger with 1 per cent novocaine without adrenalin, after applying a little rubber tourniquet in this situation. Systemic penicillin should be given.

Subcutaneous Panaris

The subcutaneous tissue of the fingers is divided into three areas by horizontal partitions of fibrous tissue which run from the skin in the situation of the transverse creases in front of the interphalangeal joints to the fibrous sheaths of the tendons behind. So that in front we can have panaris of the pulp, panaris of the second phalanx, or panaris of the first phalanx. Or the subcutaneous whitlow may be dorsal in situation.

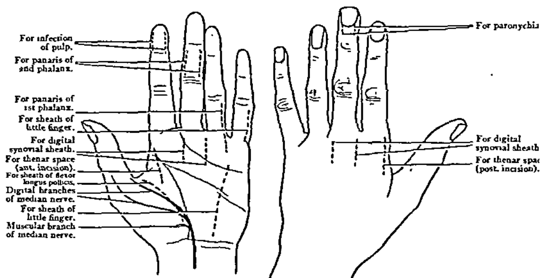
The commonest of all is the panaris of the pulp. In this situation there are a number of additional bands connecting the skin with the anterior surface of the terminal phalanx. This arrangement not only makes it difficult for the subcutaneous tissue to swell so that the tension in it quickly rises but, since nutrient vessels to the bone running in these septa are apt to thrombose, necrosis of the phalanx easily takes place. The inflammation results in the pulp being infiltrated with pus, often without there being any great collection but with necrosis of the cellular tissue. Extension may take place round to the back under the nail or sometimes into the terminal interphalangeal joint but, curiously enough, not often into the sheath of the flexor tendons except in the case of the thumb.

Clinically the infection is accompanied by considerable pain which, about the third day, becomes intense so that sleep is impossible. The pulp of the finger becomes red, swollen, exquisitely tender and tense. The normal fluctuation of the finger pulp is lost. These are the signs that pus is present and that operation is necessary. There should be no delay lest serious extension should take place, but on the other hand it should be realised that incision of an infected finger, as indeed incision in any septic area, if it is made too early, does harm, and indeed in the case of a streptococcal infection of the finger may be fraught with disastrous consequences. There is a type of infection in which the finger becomes painful and red but not very swollen or tense, which is accompanied by the red streaks of lymphangitis running up the arm. Local defence has been broken down. The infection is becoming generalised. Any surgical intervention assists this process and may turn the balance against the patient. It cannot be

proper function it is very important that they should be preserved. At the two extremities and in front of the interphalangeal joint, the fibrous sheath is much thinner. It is in these three places that the synovial sheath bulges when it is distended with fluid.

Clinically infection of the sheath should be suspected when the finger is held in semi-flexion, when attempts to straighten it passively give rise to great pain, and when there is tenderness along the whole course of the sheath but particularly at the superior extremity in front of the head of the metacarpal. Spread of the infection is liable to take place by rupture of the upper extremity of the sac into the retrotendinous space in the palm. It also takes place laterally into the commissural spaces on either side.

Treatment is carried out under general anaesthesia and with a tourniquet on the arm. Two palmar incisions are made which begin



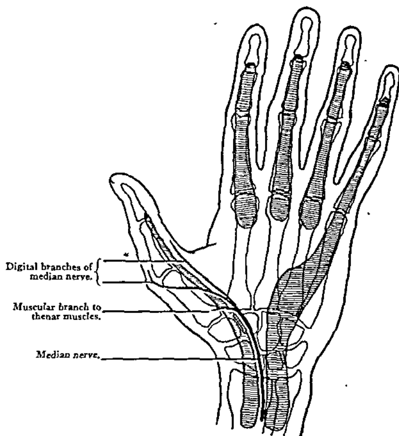
The incisions for infections in the hand.

below at the commissure on either side of the finger and are carried upwards as high as a line running horizontally from the fold of opposition of the thumb on the outer side to the flexion areas of the fingers on the inner side. The upper extremity of the sheath is opened. From each of the palmar incisions a Spencer Wells forceps is pushed towards the dorsum, an incision made over its extremity and a piece of rubber tissue drawn backwards through to the palm to act as a drain. A fomentation is applied. The hand and fingers should be fixed by a plaster of Paris splint moulded to the dorsum of the forearm and hand. Usually no more treatment is required, but if, by the third or fourth day, there is still pus coming out of the palmar incisions pointing to imperfect drainage, it will be necessary to pro-

Thecal Panaris

This is a very serious form of whitlow. Infection of the tendon sheaths usually occurs as a result of direct infection by a prick or a deep cut. Sometimes it is due to extension from a subcutaneous whitlow, and then there is always an arthritis or an osteitis and the finger is very likely to be irretrievably damaged.

The sheaths of the index, middle and ring fingers do not reach up further than the necks of the metacarpals. They are quite

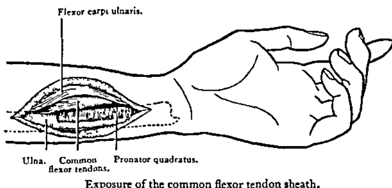


The relations of the flexor tendon sheaths to the bones of the hand. Note that the digital branch of the median nerve to the radial side of the thumb, and the muscular branch to the thenar muscles cross the sheath of the flexor longus pollicis tendon.

unconnected with the common anterior carpal sheath. It is when the thumb or little finger is affected that the infection spreads up to the wrist.

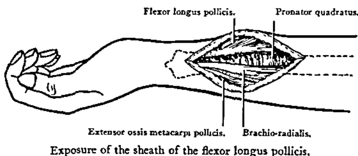
The anatomy of the flexor sheaths is important surgically. The synovial sheath of the index, middle and ring fingers extends from the neck of the corresponding metacarpal down to the distal interphalangeal joint. It is enclosed in the fibrous sheath which shows a thickening 2 to 3 cm. in length in front of each phalanx. These thickenings act as pulleys around which the flexor tendons run. For

pus will soon be found. The dorsal branch of the ulnar nerve in the subcutaneous tissue should be avoided. The upper part of the sheath of the flexor longus pollicis is drained by an incision which begins 3 cm. above the styloid process, and runs upwards along the anterior border of the supinator longus tendon for about 10 cm., avoiding the dorsal branch of the radial nerve. The radial artery is retracted forwards and the pronator quadratus again defined. At the bottom of the incision the flexor longus pollicis tendon will be found on the deep surface of which the sheath should be opened. The



Exposure of the common flexor tendon sheath.

distal part of the sheath is drained by a curved incision from the base of the thumb upwards around the thenar muscles, but it should not go higher than a finger's breadth below the lower border of the anterior annular ligament from fear of wounding the branch of the

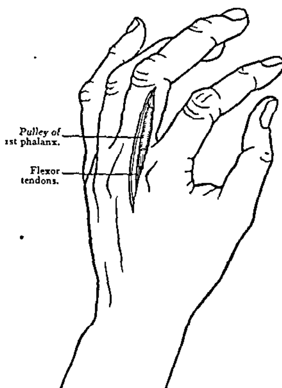


Exposure of the sheath of the flexor longus pollicis.

median nerve going to the short muscles of the thumb. The tendon sheath is reached by dissecting between the flexor brevis pollicis and the oblique part of the adductor pollicis. Very often the sheath will already have ruptured into the cellular planes of the forearm and perhaps additional drainage for this will have to be provided by prolonging the ulnar incision upwards. This rupture of the sheath is sometimes rendered evident by a numbness of the finger-tips due to a median neuritis. Drains should be of vaselined gauze or rubber tissue and a dorsal splint of plaster of Paris should be applied to the forearm and the backs of the fingers and thumb. During the early

long the dorsal incision one side downwards along the line which marks the separation of dorsal from palmar skin, and to cut the pulley in front of the first phalanx. This incision leaves the palmar digital artery and nerve in front.

Infection of the synovial sheath of the thumb is exceedingly serious. It spreads upwards in front of the wrist and very often from there into the common sheath of the flexor tendons of the fingers, and so downwards along the sheath of the little finger. When this happens the hand is held in a clawed position and the attempt to straighten the fingers or thumb is intensely painful. Tenderness is felt along the tendon sheath of the thumb and in front of the wrist above and below the anterior annular ligament, and also perhaps along the sheath of the little finger. Spread may take place into the thenar space, into the cellular space of the palm in front or behind the tendons, upwards in the cellular spaces of the forearm, or what is much worse, into the wrist joint. Inflammation spreading to the median nerve may cause tingling and numbness in the index and middle fingers.



Operation for drainage of the flexor synovial sheath when an opening in the uppermost cul-de-sac in the palm is insufficient.

In the treatment of this serious condition it is necessary to open the sheath of the flexor longus pollicis and its extension under the anterior annular ligament of the wrist, the sheath of the little finger and the common flexor tendon sheath at the wrist. The distal part of the sheath of the little finger is drained by an incision which runs from the flexion sheath crease at the base of the little finger along the radial side of the tendon up to the lower level of the annular ligament of the wrist joint. The common flexor sheath of the fingers is drained by an incision which runs along the anterior border of the ulna beginning below, 2 cm. above the styloid process, and running up for about 10 cm. The deep fascia is divided and the surface of the pronator quadratus defined. Keeping to the surface of this muscle and retracting the ulnar artery and nerve forwards, the

spaces between the bases of the fingers. The middle palmar space is imperfectly separated into deep and pre-tendinous spaces.

Infection of the thenar space is common. The thumb is forced into a fixed position of abduction. There is a tense, very tender swelling of the thenar eminence which stops on the medial side at the limiting crease. The rest of the palm is supple and not tender. At the commissure there is redness and swelling which spreads on to the dorsum.

Treatment.—The pus lies in front of the adductor of the thumb. The incision is made just lateral to the second metacarpal shaft in front and a second incision is usually required to drain the pus on the dorsum.

Infection of the hypothenar space is quite uncommon. The pus lies between the muscles and the aponeurosis. A simple anterior incision suffices.

Infection of the middle palmar space is most common behind the tendons. It is usually due to the spread of a tenosynovitis of one of the fingers. In such a case after the surgical drainage of the sheath, the temperature having fallen rises again, the swelling does not go down and the pain returns. There is great tenderness in the palm and a swelling here which spreads around the commissures on to the dorsum of the hand. Any attempt to move the fingers passively causes great pain. There is a paralysis of the interossei muscles and, owing to a neuritis of the digital nerves, trophic changes appear on the fingers. The treatment is very simple. It consists in prolonging upwards into the palm the incisions already made in the commissural space to drain the sheath. Rubber tissue is then inserted deep to the tendons.

In pre-tendinous infection of the middle palmar space the pus lies under the aponeurosis with the tendons and their sheath, the arteries and nerves, behind. The pus is not great in amount. It may perforate the fascia and become subcutaneous or spread into the thenar or the commissural spaces. The palm is painful and tender and presents a swelling. The treatment is to make a longitudinal incision through the palmar fascia. There is no danger of wounding vessels or nerves as they are behind the pus.

With all infections of the palm there is much swelling of the dorsum of the hand. Sometimes there is actual infection of the back of the hand without any lesion in the palm. The pus is subcutaneous. The best place for incision is at the base of one of the fingers. More than one incision may be desirable.

Of course vigorous penicillin treatment must be instituted.

post-operative period constant search should be made for spread of the infection to the cellular tissue of the palm or forearm or to the wrist joint. If suppuration should take place in this joint, apparently the choice of treatment lies between resection of the wrist joint and amputation. A secondary haemorrhage from the radial artery may have to be dealt with. Systemic penicillin treatment is very necessary here.

Osteal Panaris

Infection of the phalanges, except in the case of infants, is always secondary and is most common in the terminal phalanx in association with panaris of the pulp. It is the distal part of the bone which dies, the epiphysis as a rule remaining intact, as does the terminal interphalangeal joint. Time should be allowed for the sequestrum to separate, when it should be removed by an incision which runs along the lateral border of the phalanx and, according to circumstances, over the extremity of the finger. For if a large part of the bone is lost it is better to remove the distal part of the nail with its matrix. Otherwise when the finger heals the nail will cap it in a very ugly and inconvenient fashion.

Articular Panaris

An interphalangeal arthritis may occur from a direct penetrating injury, or be due to extension from a subcutaneous or thecal whitlow. Primary infections are easy to recognise by the swelling on the dorsum, the pain and flexion of the joint. The secondary ones are often masked.

Primary arthritis should be treated by a palmar splint with the joint slightly flexed. Secondary infections and primary infections which have suppurated are very serious. In the case of the fingers amputation is the best treatment, but in the case of the thumb resection of the joint to provide free drainage should always be given a trial.

B. *Infections of the Cellular Tissue of the Hand*

The palmar fascia sends two partitions backwards which separate the median palmar space from the thenar muscles on the outer side and from the hypothenar muscles on the inner side. The latter partition is attached behind to the fifth metacarpal shaft, the former to the third. Above, the space extends to the neighbourhood of the wrist, below to the level of the heads of the metacarpals where, around the lumbricals, it becomes continuous with the commissural

may have been interfered with so that it sloughs. In the very advanced cases it is probably better to perform a fasciotomy first in order to bring about a partial replacement and to leave the excision of the fascia to a later stage when it is possible to prepare the skin properly for operation. Another factor which must be taken into account is the length of time that an advanced deformity has existed, for if the fingers have remained flexed a considerable time, the anterior portions of the collateral ligaments of the affected joint will be permanently shortened. Although the fascia can be removed, extension of the fingers will still be resisted by these contracted structures. Many incisions have been devised for removing the palmar fascia. The most generally useful one is the straight vertical incision in a line with the middle of the finger. This operation should only be performed in the bloodless field provided by a tourniquet, because great care must be taken to preserve the digital nerves. These nerves actually pass through the slips which run to the sides of the phalanges where they are in great danger of being damaged. Anaesthesia of one side of a finger is a serious handicap in many occupations. When skin has been devitalised in dissecting it off the fascia it is better to excise it and to fill the gap by a full thickness skin graft. The results of excision of the fascia in early and not too advanced cases are extremely good.

Congenital Contracture of the Fingers

This affects, as a rule, the little finger. It differs from Dupuytren's contracture in that the metacarpal phalangeal joint is not affected and the terminal interphalangeal joint may be.

In children it is best treated by manipulation and splinting, but bad cases may require excision of the head of the phalanx in order to straighten the finger.

Dupuytren's Contracture

This is a contracture of the palmar fascia. It occurs usually in middle-aged people and affects, as a rule, that part of the fascia which goes to the ring finger. It should be remembered that the middle portion of the palmar fascia divides into four digitations which go to the four fingers, and that each digitation splits up into a strand which becomes continuous with the fibrous sheath of the tendons and lateral slips which are inserted into the dorsal surface of the first and second phalanges. When this structure contracts there occur, first, a flexion at the metacarpo-phalangeal joints, and secondly, a constriction at the first interphalangeal joint. The terminal joint of the finger is not affected. The ring finger is the commonest one to be deformed, then the little finger. The index finger and middle finger are only occasionally involved.

The cause of the disease is quite unknown. It is said to occur in people who labour with their hands, but this is not universally true. The deformity takes several years, as a rule, before it becomes pronounced, but it may become so great that the tip of the affected finger is actually forced into the palm of the hand. The condition is very easy to diagnose clinically because the thickening of the fascia is easily perceptible beneath the overlying skin, which becomes atrophic and adherent to it. That the deformity is not due to contraction of the tendon is easily proved by flexing the wrist to relax the tendon, when it will be found that it is still impossible to extend the fingers.

The treatment of this disease is much easier in the early stages. Two methods are employed: (1) subcutaneous fasciotomy (syndesmotomy), (2) excision of the diseased fascia.

Subcutaneous syndesmotomy is performed with a small tenotomy knife which first separates the skin from the underlying fascia and is then directed backwards to divide the fascia itself. This should be done in several places. After this the fingers are extended forcibly and a splint applied. The results of this treatment are not very satisfactory. It is necessary for splints to be used at night for many months and relapses are very common, so that excision of the fascia is usually recommended. There are certain difficulties, however, in carrying out this operation. If the fingers are in close contact with the palm it is not possible to prepare the skin properly for operation. Sepsis is likely to ensue, with perhaps disastrous effects. A number of cases of gangrene of a finger have been reported after operations for Dupuytren's contracture. The second difficulty in carrying out the operation is the closure of the wound after the fascia has been removed. The wound is likely to gape and, moreover, the vitality of the skin

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begin to excrete the dye in 3 minutes, when it appears as a pale blue: within 1 minute it will have become very dark in tone. If the kidney function is much depressed, there is delay in the appearance of the blue colour; sometimes it is scarcely visible; it always remains pale for longer, and the dye may never become concentrated enough to be a dark blue. If the efflux from the ureters be watched through the cystoscope, a comparison between the function of the kidneys on the two sides can be made. Normally there is never a delay in the appearance of the blue colour at the ureteric orifice longer than 9 minutes. Intravenous pyelography is described on page 674. If the kidneys are seriously diseased they cannot concentrate the uroselectan enough to allow of the X-ray revealing the shape of the pelvis and calices. It, therefore, becomes a test of renal function. The urea clearance test, which is regarded as the most exact test of renal function in the investigation of medical diseases, is not of so much use in surgery, because its accuracy is interfered with by urethral instrumentation which is so often necessary.

Congenital Affections of the Kidney

Sometimes the kidney on one side is congenitally absent, though there are two ureteric openings, on inspection within the bladder. At other times the lower ends of the two kidneys are fused together across the middle line in front of the aorta (horse-shoe kidney). The ureters in this case, instead of lying behind, run over the front of a bridge between the two kidneys. Such kidneys are particularly liable to become hydronephrotic in one of their constituents. They are usually palpable, as a tumour within the abdomen lying in front of the spine. Sometimes the two kidneys lie together on one side of the body, the ureter of the kidney which has crossed over opening in a normal fashion into the bladder. Another abnormality which is rather frequently seen is lobulation of the kidney so that on one side there may appear to be two organs in place of one, each with its own ureter. The two ureters may open separately into the bladder or join together before doing so. An ectopic kidney is one which lies in some abnormal position, usually in the iliac fossa, where it may give rise to some confusion in diagnosis.

Polycystic kidneys are also the result of a congenital abnormality in which some of the renal tubules fail to make proper connection with the metanephros. The condition is one in which there are a number of cysts in the kidney. It is bilateral. These kidneys are usually palpable in the abdomen because they are so large. The patient may live for many years without symptoms. Their urine is like that of

CHAPTER XLVII

DISEASES OF THE KIDNEY

Tests of Renal Function

In some surgical conditions where it is contemplated throwing a serious strain upon the kidneys by a severe operation such as a prostatectomy it is very important to be able to estimate the function of the kidneys in order to avoid stressing them to a point which they are unable to withstand and which will result in the patient dying from uraemia. In this country, as far as surgery is concerned, there are four useful tests: the estimation of the amount of urea in the blood; the power of the kidneys to concentrate urea in the urine; the ability of the kidneys to excrete indigo-carmine; the power of concentrating uroselectan from the blood so as to allow a pyelogram to be made.

The amount of urea in the blood in health varies between 15 and 40 mg. per 100 c.c.; if there are 50 mg. present in this volume then there is a serious loss of renal function and the contemplated operation may have to be modified or postponed. The urea concentration test is carried out by estimating the amount of urea in the urine in the early morning when the patient has had nothing to drink since 10 P.M. the night before. He is made to empty his bladder at 6 A.M., when he is given a drink made up as follows: urea, 15 gm., tincture of orange, 1 c.c., water to 100 c.c. Specimens are then taken at 7, 8 and 9 A.M. The volume of urine passed in the first hour should not exceed 120 c.c. (4 oz.). In the succeeding two hours it should not exceed 100 c.c. ($3\frac{1}{2}$ oz.). If a greater volume of urine than this is passed, the test is not reliable and it should be repeated. The amount of urea in these three specimens is estimated and the maximum only taken into account. It should be at least 2 per cent and is usually much higher. If there is less than 2 per cent of urea present then there is renal inadequacy.

The indigo-carmine test is carried out by injecting 5 to 10 c.c. of 0·4 per cent indigo-carmine intravenously. A normal kidney will

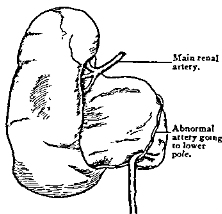
may be renal colic. After a few days, blood-staining appears in the loin, scrotum or labium majus.

In the lesser degrees of injury the patient is given morphine and *kept quietly in bed. The indication for operating is increasing* anaemia and an enlarging tumour in the loin, or suppuration in the infiltrated perirenal tissues. In all cases where operation is decided upon, it is best to make an incision in the loin, for even if the peritoneum is torn, or there is an intraperitoneal lesion, it will be possible *to deal with it from this aspect by prolonging the incision forwards.* A tear of the parenchyma alone may be cured by suturing it, but an injury of a large vessel in the hilum will necessitate nephrectomy. A perirenal abscess will need nothing but adequate drainage, though a nephrectomy may sometimes be required later on.

In open wounds of the kidney it is necessary to explore the wound, stop haemorrhage by suture or nephrectomy, and provide drainage.

Hydronephrosis

This is a condition in which there is a dilatation of the pelvis and calices of the kidney. It is due to an intermittent obstruction in the urinary tract below this level. If the obstruction is at the neck of the bladder or distal to this, then the hydronephrosis is bilateral. Such causes of obstruction are a pin-point meatus, a congenital valve within the prostatic urethra (a very rare occurrence), an enlargement of the prostate, or, in women, a carcinoma of the cervix uteri which has invaded the lower ends of both ureters. A gonococcal stricture of the urethra gives rise to dilatation of the pelvis of the kidneys perhaps, but the urine is always infected and so the condition should properly be termed a pyonephrosis.



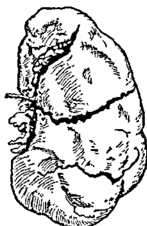
Hydronephrosis due to congenital ureteric stricture. The pelvis has bulged through an interval between the renal artery and an abnormal artery going to the lower pole.

A unilateral hydronephrosis is due to some intermittent obstruction of the ureter on one side. The commonest cause of all is the impaction of a calculus in the neck of the renal pelvis. The next common cause is a congenital narrowing at the uretero-pelvic junction. Other causes are the presence of an abnormal renal artery, kinking of the ureter from hypermobility of the kidney, rarely, obstruction

chronic interstitial nephritis, that is, there are a polyuria, a low specific gravity and a trace of albumen. The disease is a progressive one, so that ultimately the patients die from uraemia. No surgical treatment is ever required for this condition.

Injuries to the Kidney

A subcutaneous injury of the kidney occurs from blows on loin or abdomen or in run-over accidents. The organ is crushed against the vertebral column or penetrated by a fractured rib. The tear in the kidney may be near the surface and involve only a small part of the parenchyma, or it may run in a radial manner into the hilum where, as likely as not, it opens into the pelvis. There is usually a lot of blood poured out, which collects in the perirenal space. If the tear is deep, urine will also be extravasated. The blood tends to pass along the ureter, and towards the scrotum. The ureter may actually be torn from the pelvis; and sometimes the peritoneum is lacerated at the same time, so that the blood and urine can get into the peritoneal cavity.

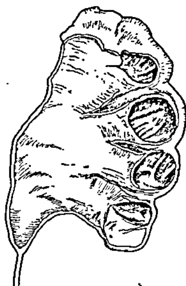


Ruptured Kidney.

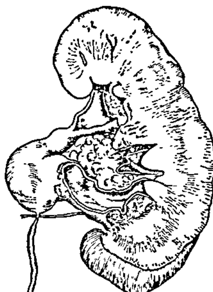
There is always considerable shock with a rupture of the kidney. The pulse is small and rapid, the face pale, the skin sweating. This pallidity passes off to some extent unless there is very great haemorrhage, when it will merge into the anaemia of blood loss. Locally there are tenderness in the loin, and spasm of the muscles of the loin and anterior abdominal wall of the same side. After an hour or two the rigidity often passes off enough to allow a tumour in the loin to be felt: it is a perirenal haematoma. A watch on the size of this haematoma must be kept; an increase denoting perhaps a serious loss of blood. Blood is passed in the urine unless the ureter has been torn off the pelvis of the kidney. This haematuria in mild cases may last for one or two weeks, gradually lessening. It is very difficult to decide whether there is an accompanying tear in the peritoneum, because the renal injury being in the neighbourhood of the coeliac plexus may itself give rise to distension and vomiting. When blood is being poured into the peritoneal cavity, the abdominal rigidity is not likely to pass off, no tumour grows in the loin, and there is a dulness in the abdomen, beginning on the side of the injury. The pain in laceration of the kidney is not only felt in the loin; it radiates to the groin, thigh and genitals; if blood-clots pass down the ureter, there

between the first and second parts of the duodenum and at other points in the alimentary canal.

It is to be remembered that the urine reaches the pelvis of the kidney at a constant trickle, but the discharge of this urine into the bladder takes place by peristaltic waves along the ureter which only occur at intervals which are sometimes as long as three minutes; so



Hydronephrosis. Calical type. The bulging calices have destroyed the pyramids and hollowed out the kidney substance.



Hydronephrosis. Pelvic type. The kidney substance has not been destroyed. The apices of the pyramids retain their shape. An abnormal artery runs behind the ureter, but obviously has no causal relationship.

that the urine collects in the pelvis, where it is retained by a contraction at the uretero-pelvic junction and is expelled from it from time to time by contractions of the pelvic wall. Failure of this contraction ring to relax sufficiently to allow of the escape of all the urine in the pelvis leads to a hydronephrosis. The explanation of the hydronephrosis due to the nephroptosis is considered on page 678.

It is a curious fact that, in this affection of the kidney, the dilatation sometimes affects the pelvis alone and not the calices, whilst at other times the calices are distended whilst the pelvis retains its normal shape; so that we can speak of pelvic or calical forms of hydronephrosis. It is important to distinguish between these two varieties because, in the calical type, the pressure leads to an atrophy of the apices of the pyramids and thrusting backwards up the connecting tubules against the secreting epithelium, damages these cells; whilst in the pelvic type the kidney tissue seems to be protected from

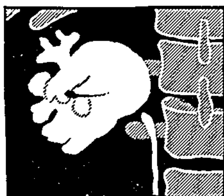
of the lower end of the ureter by a papilloma of the bladder, occasionally the blocking of the ureter by a growth of the kidney, and, more commonly, a disturbance of the relation between the movements of the pelvis and ureteric peristalsis. We have already seen that there are three places in the ureter which are narrow in foetal life but increase in size with growth. That at the uretero-pelvic junction may fail to reach an adult normal calibre. It constitutes the so-called congenital stricture of the ureter, but inflammatory changes take no part in the production of this constriction.

If we take the normal secretion of urine to be 50 oz. in 24 hours, each kidney will secrete 25 of these. Let us, for the sake of argument, suppose that the greatest amount passed in any one hour is 2 oz. The lumen of the ureter must obviously be sufficiently great to allow this amount of liquid to pass in that time. If it is not, the liquid will accumulate behind the narrow part of the ureter, thus leading to a dilatation of the kidney pelvis. The congenital narrowing may not be sufficient to cause this damming-back of the urine under the ordinary conditions of life; but should there for any reason occur a polyuria, such as might result from the excessive intake of liquid, or such as will come on with a mild degree of interstitial nephritis, then the ureter may become inadequate to carry off the increased amount of urine. This is how hydronephrosis with congenital stricture of the ureter arises; and it can be understood how, on occasion, symptoms do not occur until long past childhood, even well into middle age. As a rule, however, a patient with congenital narrowing of the uretero-pelvic junction has symptoms in the second ten years of life.

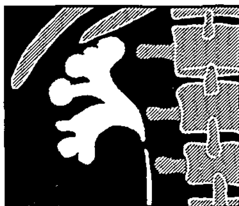
An abnormal renal artery which goes to the lower pole of the kidney and crosses behind the ureter instead of in front of it is given as a cause of hydronephrosis more often than is actually the case. Such abnormal arteries are not at all uncommon, and a number of examples of hydronephrosis in which they exist are really not due to pressure of the artery against the ureter but to congenital stricture. The dilating pelvis above the stricture sags down over the artery so that it comes to simulate, at first sight, an obstruction from this artery. A closer inspection shows that the dilatation does not arise at the point of crossing but higher up at the uretero-pelvic junction. There are quite a number of cases of hydronephrosis which, on exposure at operation, show no stricture at the uretero-pelvic junction, although the pyelogram would lead one to expect that such is present. Undoubtedly such dilatation of the pelvis is due to a muscle spasm at this point. No anatomical sphincter can be demonstrated here, but physiologically there is one, just as a physiological spasm occurs

have the power of extracting from the blood, and excreting in concentrated form, so that the urine becomes opaque to the X-rays. The drug is usually injected into one of the superficial veins of the forearm and X-ray photographs are taken at definite intervals afterwards, to trace the progress of the secretion. If the kidneys are damaged, the excretion of the drug is delayed or the power of selecting it from the blood-stream may be so diminished that it is never got rid of in any concentration great enough for shadows to be obtained. This test, therefore, not only demonstrates the shape of the pelvis and calices but gives evidence also of the functional power of the kidneys.

Perurethral or ascending pyelography is carried out by passing a catheter into the ureter and injecting through it a 13 per cent solution of sodium iodide. In doing this the pressure should never be raised



Pyelogram: pelvic type of hydronephrosis.



Pyelogram: calical type of hydronephrosis.

higher than the secretory pressure of the kidney (about 80 mm. Hg), and indeed it is better to keep the injection pressure down to 45 mm. Hg, which can easily be done by an apparatus devised for this purpose. Perurethral pyelography is nearly always followed by a good deal of pain and perhaps true renal colic. It is said that if uroselectan be used, this pain is not caused, but the drug being viscous, it must be forced under considerable pressure along the narrow lumen of the ureteric catheter, which is not good.

The shape of the renal pelvis and calices is normally subject to considerable variation. There are certain points in the shadow of which notice should be taken. The lower margin of the pelvis should pass in a continuous curve into the ureter. A flattening of this curve and a bulging downwards of it indicate early hydronephrosis. The medial side of the ureter also passes straight up into the pelvis in the normal condition: in hydronephrosis there is a bulge towards the spine. If the calices have been distended for a long time, instead of having the normal bifid extremities due to the projection of the

this back pressure by contraction of the muscle around the necks of the calices. In the calical type not only does the epithelium degenerate, but there is a slow chronic inflammatory change in the interstitial tissue. In extreme cases the kidney becomes hollowed out so much that it is a congeries of sacs containing urine and the kidney is functionless. A pelvic hydronephrosis always ends as a combined calical and pelvic dilatation.

Symptoms.—It is possible for a patient to know nothing about the development of a hydronephrosis until he discovers a tumour within his abdomen. A renal tumour typically forms a swelling in the upper part of the abdomen largely concealed by the costal margin, which is rounded in form, moves up and down with respiration, is felt easily between two hands, one on the front of the abdomen and one on the renal angle behind, and is resonant on percussion in front. On the right side such a tumour must be differentiated from an enlargement of the gall-bladder. But the gall-bladder lies right up against the abdominal wall. There is no sensation of the fingers dipping down as they do to reach the anterior surface of the kidney; moreover, the gall-bladder is dull on percussion and the dulness is continuous with that of the liver above. Hydronephroses which arise silently in this manner are the exception rather than the rule. Usually the patient suffers from attacks of renal colic, these attacks being precipitated by the sudden fixation of a stone at the pelvic outlet; the dropping and kinking of the ureter in a movable kidney; an abnormally rapid secretion of urine when there is a congenital stricture; or perhaps a reflex spasm of the uretero-pelvic junction from the dropping of a movable kidney. These attacks of renal colic are typical, but there is not, as a rule, haematuria unless the hydronephrosis is due to an impacted stone. The actual enlargement of the kidney in the early stages is usually too small for it to be detected by palpation. The colic will last, perhaps, for some hours and then give way, when it is followed by a polyuria. This is not due to the amount of urine collected in the hydronephrosis, which, under ordinary circumstances, is never large enough to fill the bladder even once; but results from a reflex hypersecretion, the response to the damage done by the previous hindrance to the outflow. The diagnosis is made by a skiagram and pyelography.

Pyelography is the demonstration of the conformation of the pelvis and calices by filling them with some liquid opaque to the X-rays.

Intravenous pyelography is carried out by injecting into the circulation a substance, usually a derivative of pyridine containing a large percentage of iodine (uroselectan or perabrodil), which the kidneys

inspection of the uretero-pelvic junction should be carried out to make certain that there is no pathological change here.

When there is a hydronephrosis and there is no narrowing of the ureter, the condition can be corrected by performing a nephropexy, as it appears to be due to a reflex spasm of the uretero-pelvic junction owing to the dragging of a heavy kidney. The operation of decortication of the renal artery in order to cut off the sympathetic supply to the ureter has been carried out for this condition, but the operation is not always effective and it is a delicate procedure which is associated with some danger of damaging the renal vessels.

A hydronephrotic kidney, when due to a congenital stricture of the ureter, should never be removed if it can be possibly avoided, because it is very likely that there is some narrowing of the opposite ureter which, after removal of one kidney, will be inadequate to carry away the whole of the urine secreted by the body. The hydronephrosis will develop on the side of the remaining kidney. Also operations designed for lessening the capacity of the renal pelvis by resection of a portion of its wall are bad. If the lumen of the ureteric junction is only just adequate for normal purposes, it is a protection to have a potential reservoir above it. Indeed after the operation of uretero-pyeloplasty has given complete relief for many years, there may still be found, on pyelography, some enlargement of the renal pelvis: an enlargement which is an insurance against further attacks of renal colic. In other cases, when a kidney has been so destroyed by a hydronephritic process that it is largely functionless, it should be removed.

Nephroptosis

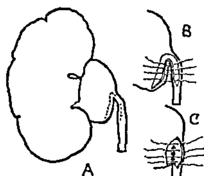
The kidneys, like other viscera within the abdominal cavity, are supported chiefly by the tone of the muscles of the anterior abdominal wall.

The term nephroptosis is applied to kidneys which are abnormally movable behind the peritoneum. There is a quite normal excursion of the kidney up and down with respiration; but when it is movable, it is possible to feel the upper pole at the end of inspiration, and very likely, to hold the kidney in this low position, when the patient subsequently breathes out. The kidney is said to be wandering when it is possible to push it over to the opposite side of the body or perhaps right down into the iliac fossa. Abnormal mobility of the kidney is seen far more often in women than in men and in persons of the tall, thin, narrow-chested, asthenic type. They are often highly nervous, though whether, as is very likely possible, this is due to the same inherent defect of the sympathetic nervous system responsible for the

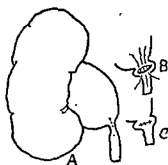
apices of the pyramids into them, there is a flattening-out of this angle and an actual rounding of the ends of the calices (clubbing of calices).

Treatment.—The treatment of hydronephrosis is always operative, and is necessary because the condition is progressive and leads to slow destruction of the kidney secreting tissue. Of course, when a hydronephrosis is due to immovable malignant disease, as in the latter stages of carcinoma of the cervix, then treatment is contra-indicated. In bilateral cases the obstruction due to strictures of the urethra or an enlarged prostate must be removed. In unilateral cases the pathological lesion is usually at the upper end of the ureter, so that the kidney is exposed by an oblique lumbar incision. Should there be a stone blocking the pelvic outlet it must be removed.

For congenital stricture of the upper end of the ureter several procedures are available. The pelvis may be opened and a narrow



Uretero-pyeloplasty by an inverted U-incision.



Fenger's uretero-pyeloplasty.

haemostat pushed through the stricture which is distended by gently separating the blades. Then one or two vertical incisions are made in the muscle of the ureter down to the mucosa. A large ureteric catheter is passed through the stricture and allowed to remain for from ten days to three weeks. The pelvis should also be drained by another narrow tube. Fenger's uretero-pyeloplasty consists in making a vertical incision through the stricture into the lumen of the ureter and suturing the wound transversely. A ureteric catheter need not be used after this operation but the pelvis must be drained through a separate small incision. When the ureter is attached high up to the pelvis an inverted U-incision is made of which one limb is on the pelvis and the other down the ureter. The resulting wound is sutured so that the adjacent edges are joined together and the far edges sewn over them.

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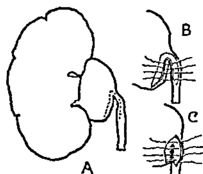
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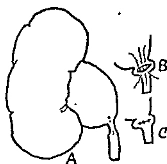
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absence of tone of the abdominal muscles, owing to a sluggish visceromotor reflex, or whether it is due to the constant pain which some of them have from the dragging of the heavy kidney on the renal sympathetic plexus, is not definitely decided. It is certainly true that many women have movable kidneys and yet suffer in no way from this abnormality. In pathological mobility there is a constant complaint of pain in the back, which is relieved by lying down, and particularly by lying down on the back with the foot of the bed raised. Such patients also sometimes have attacks of acute pain and vomiting which have all the features of renal colic (Dietl's crises). Treatment is never required simply because the kidney is abnormally mobile, but if these crises, which are thought to be due to a kinking of the ureteric pelvic junction, occur, or if there is pain in the back very definitely relieved by lying down, then therapeutic measures are desirable. The ureter in the whole of its length is much more fixed than the kidney itself, so that, when the kidney drops, it causes a kink at the uretero-pelvic junction. The musculature of the wall of the renal pelvis is not powerful enough to straighten out this kinking, for, in doing so, it would perforce have to raise the weight of the kidney. Thus, a hydronephrosis may develop which will be revealed by intravenous pyelography; so an indication for operating on a movable kidney is the existence of a dependent hydronephrosis. When the patient complains simply of the pain which is relieved by recumbency without there being any dilatation of the renal pelvis, a belt which supports the kidney in its proper position with the aid of a pad should be tried first. Only if this fails should an operation be done. In both these cases the operation performed is known as nephropexy. In this the capsule is stripped from the posterior surface of the kidney and used as slings to fix the organ to the bared surface of the quadratus lumborum, between which and itself adhesions form. A careful inspection must always be made of the uretero-pelvic junction in case there should be some abnormality in this situation which needs correction.

Pyogenic Infections of the Kidney

Acute Pyelitis

The kidney becomes infected with pyogenic organisms by two routes: ascending along the lumen of the ureter, when there is an infection in the bladder; or by the blood-stream (*haematogenous*). Under certain conditions antiperistalsis can take place up the ureter, and convey microbes from the bladder to the kidney. For example,

with a full bladder, a forcible effort at expulsion will sometimes cause pain in the renal area which is due to a reflux of urine; occasionally during cystoscopy particles in the bladder will be seen to disappear into the ureteric orifice; and with X-rays, an opaque fluid in the bladder has been seen to pass up the ureter into the renal pelvis. In the haematogenous infection, microbes pass from the blood into the renal tubules and travel down to the pelvis, where they set up an inflammatory reaction. The kidney may show no signs of infection itself, even on the most careful examination. Predisposing factors are stagnation of the urine, the presence of a stone, or an injury. The passing of a catheter will sometimes set up a pyelitis or pyelonephritis, an inflammation which is conveyed from the urethra to the kidney by the blood-stream, because, before the signs of pyelitis appear, organisms have been found in the blood itself. Eighty per cent of infections of the pelvis of the kidney are due to the *Bacillus coli*; the next common invading organisms are staphylococci and streptococci; other organisms are very much rarer as excitants of pyelitis. Pyelitis is more frequently seen in women than in men, and in girls than in boys.

The three symptoms are pyuria, pain and fever. There is frequently a rigor to begin with, followed by a temperature which is intermittent in type. During the height of the fever the organisms can often be recovered by blood culture. The pain is felt in the loin and the kidneys are protected by muscle spasm. A pyelitis is very frequently bilateral, but if only one side is affected it is nearly always the right side. There may be so much swelling of the mucous membrane of the renal pelves that obstruction is caused and, with it, attacks of renal colic. There are frequency of micturition and strangury. Although there is a high temperature, the face is often pale. The tongue is dry, the pulse small and rapid. Vomiting is frequent and there may be either diarrhoea or constipation. The *Bacillus coli* infections tend to subside and do not, as a rule, threaten life; but a staphylococcal or streptococcal infection may lead to general septicaemia with cloudy swelling of the liver and myocardium, a septic spleen and death. Although the acute symptoms of *Bacillus coli* pyelitis tend to disappear, the disease is very apt to become chronic and the patient lives in a state of equilibrium with the attacking organism — a bacteriuria in fact, without an infection; but at any moment, should the resistance fall, the organisms are liable to invade the tissues.

The pyelitis of pregnancy is predisposed to by obstruction: the enlarged uterus presses upon the right ureter at the pelvic brim. Above this point the ureter is dilated.

Children, especially small girls above 3 years of age, are prone to suffer from a *Bacillus coli* infection of the pelvis. The temperature resembles very much that in adults, but the bladder symptoms are frequently wanting. The child has a white face but an examination of the blood shows that it is not really anaemic. It is apathetic, has stiffness of the back, neck muscles and extremities, with perhaps convulsions, so that the condition may resemble, in some respects, meningitis. There are vomiting and diarrhoea. However, examination of the urine will show the presence of pus as in adults. The urine in *Bacillus coli* pyelitis is acid in reaction.

A staphylococcal infection of the kidney is rather suggestive of the presence of a calculus.

In the treatment of pyelitis, rest in bed is essential. During the acute stages the patient should be given a mixture composed of potassium citrate 20 gr., tincture of hyoscyamus ½ dram, infusion of buchu to 1 oz. 4-hourly. This, as a rule, gives great relief. At the same time the kidneys should be flushed by the intake of large volumes of water or barley water. The diet should be mainly a liquid one. Morphine may be necessary if renal colic occurs. In *Bacillus coli* infections, when the acute symptoms have subsided, the patient should be given a course of sulphadiazine or sulphathiazole. When after one or more trials of sulphonamide therapy the infection is not overcome, then mandelic acid should be given. Three grams of mandelic acid is the usual dose. It is given in the following mixture: mandelic acid 3 gm., sodium bicarbonate 1·6 gm., syrup of lemon 15 c.c., water to 30 c.c. This is given 4 times a day, and at the same time 1 gm. of ammonium chloride in a cachet must be given 4 times a day in order to keep the urine acid, for unless the *p*H is about 5, the drug will be ineffective. Ammonium chloride sometimes disturbs the digestion and it may be avoided by giving calcium mandelate, a tasteless powder, in 4·4 gm. doses in milk 4 times a day: for this drug acidifies the urine. This mandelic acid treatment is maintained for 7 or 10 days, when an examination of the urine will very likely prove it to be sterile. If it is not, another course should be given in a fortnight's time. The mandelic treatment is also effective in *Streptococcus faecalis* infections. The older urinary antiseptics, such as hexamine, are so ineffective that they are not often employed.

The pyelitis of pregnancy being due largely to obstruction can be treated with very little trouble by the passage of a ureteric catheter. This small manœuvre will frequently bring the temperature down immediately. The catheter may be left in for 7 or 8 days. This form of pyelitis always recovers after the birth of the child and an abortion for its relief is never necessary.

Penicillin is of use in infections of the kidney when the organism is susceptible. Unfortunately this is only the case in about one-fifth of the patients.

Suppurative Nephritis

Infection of the kidney tissue itself takes place in the same way as it does in pyelitis. The organisms in the blood-stream are held up in the glomeruli, so that abscesses may form in the cortex of the kidney; or, passing into Bowman's capsule, they may travel down the renal tubules and so give rise to an infection in the pyramids. An infection which ascends from the bladder affects the medullary part of the kidney most. The *Bacillus coli* has not much tendency to invade the tissues of the body, so that suppurative nephritis is usually due to the staphylococcus or the streptococcus. Sometimes a staphylococcal infection of the kidney will give rise to an area of acute inflammation with necrosis (carbuncle of the kidney). The signs and symptoms of the suppurative nephritis are very similar to those of acute pyelitis but both general and local symptoms are more pronounced. An abscess in the kidney may reach the surface and infect the perinephric tissues. The function of the kidneys, as shown by the excretion of indigo carmine, is depressed.

The treatment is very much the same as that of pyelitis but operative measures are more commonly called for, as an abscess in the kidney or a perinephric abscess may need opening. When, with very acute symptoms on one side only, it is suspected that there is a carbuncle of the kidney, the threat to life is so great that it is sometimes advisable to perform nephrectomy or, if possible, a partial nephrectomy. The disease is very apt to spread to the veins, causing a pyaemia, and, after nephrotomy, a secondary haemorrhage is a rather common complication. The infecting organism being a staphylococcus, penicillin is likely to be of great assistance.

Pyonephrosis

This is a condition in which there is an obstruction at the outlet of the pelvis which becomes dilated and is filled with purulent urine. A stone is often responsible for the obstruction, but in septic infections of the kidney the closure of the upper orifice of the ureter may be due to simple inflammatory swelling. The signs of the disease are those of suppurative nephritis. The treatment of the disease is nephrotomy and drainage or, if the renal tissue has been destroyed, nephrectomy combined with penicillin. Nephrectomy in the case of an old-standing pyonephrosis may present great difficulties owing to the sclerosis in

the surrounding parts and the fixation of the organ. Under these circumstances the true capsule is first split open and the kidney removed from within it, a procedure which can be carried out without much difficulty.

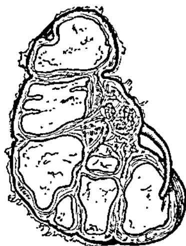
Perinephric Abscess

This is an abscess which forms in the perinephric tissues within the capsule of Gerota. It is a condition which, at its onset, is usually very obscure. There may be nothing but an unexplained fever without there being localising signs. Pain may be felt in the lower part of the chest due to a pleural rub at the base of the lung. As the inflammation in the perinephric tissues increases in extent, the loin becomes tender to palpation; there is spasm of the quadratus lumborum muscle and, later, some bulging in the renal angle. The disease is nearly always due to a haematogenous infection of the kidney by the staphylococcus, which results in a small cortical abscess bursting into the perinephric tissues. The urine may appear quite clear, but on centrifuging it, some casts and staphylococci may be found. Collections of pus also form round the kidney when neighbouring structures are inflamed, such as a retrocaecal appendix, or the spine in osteomyelitis. There should be no great hurry to operate upon a case of perinephritis, for the inflammation may subside and complete resolution take place. Whenever it becomes progressively more intense, and the presence of a high leucocytosis gives reason to think that pus is present, the abscess should be opened by an oblique lumbar incision. Penicillin systemically must be given.

Tuberculosis of the Kidney

Tuberculosis of the kidney is a disease which occurs usually in young adults. It is a secondary tuberculous infection in the body, the primary lesion being usually in a lymphatic gland draining the pharynx, lungs or alimentary canal. The tubercle bacilli are carried to the kidneys by the blood-stream and pass along the interlobular arteries by which they reach the glomeruli in which they are held up. Here they give rise to tuberculous tissue changes in the neighbourhood. The infection occurs in both kidneys at the same time, but at this stage it is not clinically perceptible. Should the disease break into Bowman's capsule, the bacilli are conveyed away by the urine and get caught in some narrow part of the tubules (*e.g.*, ascending limb of Henle's loop) in the pyramids. Here the process proceeds more rapidly, and reaches the surface of a pyramid so that a tuberculous

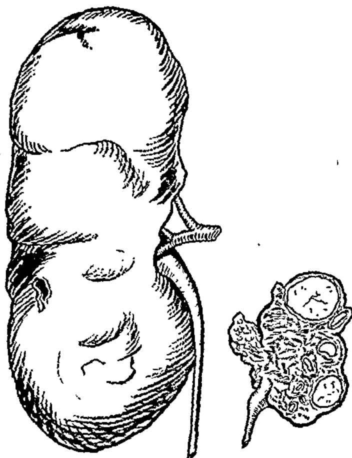
pyelitis is set up. It is at this stage that symptoms first arise. The primary renal lesions in the cortex are frequently curable, but after symptoms have occurred the disease very seldom disappears spontaneously. In the progress of the disease large areas of tuberculous granulation tissue are formed within the kidney, caseate, and perhaps soften, so that the organ becomes a congeries of cold abscesses. The ureter shares in the disease, particularly at the upper and lower ends, and its walls may get so thickened that obstruction is caused, resulting in a tuberculous pyonephrosis. Much less commonly thickening of the upper end of the ureter will lead to retention of urine in the pelvis, which has so little pus within it that it is referred to as a tuberculous hydronephrosis. Besides this caseating form of the disease there is a fibrous variety in which the characteristic change is the formation of fibrous tissue in the kidney; which, contracting, destroys all the parenchyma cells and ultimately reduces the organ to a small nodule. From the kidney the disease is apt to spread to the bladder, causing a tuberculous cystitis; and spreading from one side to the other, it may make the opposite ureteric opening rigid and gaping, as a result of which a reflux of tuberculous urine, during the act of micturition, is liable to take place; this leads to a tuberculous infection of the healthy kidney. In men the tuberculous process may spread to the prostate, the seminal vesicles and epididymis. In the caseating form of tuberculosis of the kidney the infective process sometimes invades the perinephric tissues, giving rise to an abscess.



A tuberculous kidney containing large caseous masses. All the parenchyma has been replaced by granulation and fibrous tissue.

The first symptom of a tuberculous kidney is usually an abnormal frequency of micturition. The patients are usually youngish people, below the age of 40. Some of them are quite healthy in appearance, but others are weakly-looking and strikingly anaemic. The increased frequency of micturition wears them out by interfering with sleep, and is associated with some pain at the end of the act. Occasionally there is haematuria, which may indeed be the first sign. A large pyonephrosis can be felt on abdominal palpation, but a large tender kidney in this disease is not always a tuberculous one; because the healthy kidney not only hypertrophies to carry on the excretory function for both, but at the same time is affected with a tuberculous

nephritis due to tubercular toxins absorbed from the other kidney. The diseased kidney may be shrunken up and, owing to contraction in the perinephric tissue, withdrawn under the costal margin; it is then quite impalpable. There are no other abdominal signs. In women, the thickened lower end of the ureter may be felt crossing the lateral fornix of the vagina. This is a very valuable sign and, if



A shrunken tuberculous kidney containing caseous areas, and the opposite healthy hypertrophied kidney drawn to the same scale.

associated with frequency of micturition and pus in the urine, is clear evidence of the tuberculous nature of the disease.

The urine itself is acid in reaction and always contains pus cells. Tubercle bacilli are not invariably present; they are discharged intermittently into the urine, so that in some specimens they may be swarming in numbers, and in others may be absent. For this reason, in examining for tubercle bacilli, a sample of the whole 24 hours' urine is usually taken. If, after staining the deposit of a specimen of urine, no tubercle bacilli are found, it is not worth making a prolonged search, but more profitable to examine another specimen on a subsequent day. In men, a nodule in the prostate may be felt per rectum

or the seminal vesicle thickened; or the globus minor of the epididymis enlarged.

A cystoscopic examination should always be carried out. It is not always possible to do this because of extreme contraction of the bladder and, as it is a painful procedure, a general or spinal anaesthetic should always be employed. The general mucosa of the bladder may be quite unaffected. The earliest sign is some inflammation around the ureteric orifice on the diseased side. In this neighbourhood groups of tubercles are also sometimes seen. They are small, round red nodules with a greyish centre. At other times there may be a general cystitis, the whole of the mucosa being swollen and inflamed so that the vessels have disappeared. Around the ureteric opening the inflammation and oedema may be so intense that the actual orifice is concealed. Another characteristic appearance occurs when the lower end of the ureter is diseased and contraction of the fibrous tissue takes place; the orifice, instead of being a lipped slit, is a widely open, round hole (golf-hole ureter). The object of cystoscopy is to determine whether one kidney is healthy. The most certain way of doing this is to pass a ureteric catheter into the supposed healthy ureter and collect the urine from that kidney; if it is clear and contains no pus, the organ may be regarded as non-tuberculous. Some surgeons feel that this procedure is associated with some danger of carrying tubercle bacilli into the healthy ureter and so up to the unaffected kidney. Such an accidental infection would not show itself for some months. However, there is no real evidence that this happens, and the method is so exact that it is the one usually employed. An alternative is to carry out an indigo-carmine test of renal function. The dye will be discharged normally from the healthy ureteric orifice, and be very greatly delayed, or prevented from appearing from the diseased side. It should be borne in mind that tuberculous nephritis may cause some delay in the appearance of the dye. When ureteric catheterisation cannot be performed because the ureteric orifices are invisible, or inaccessible from oedema, the dye test is useful.

Intravenous pyelography is very valuable as a diagnostic measure, as the shape of the pelvis or calices is invariably altered by the tuberculous process. It may be relied upon when cystoscopy is impossible.

The prognosis, as far as healing is concerned, when once the disease has broken through to the pelvis of the kidney, is very poor. Spontaneous recovery, whilst it is known, is rare; but since the disease is unilateral in a clinical sense for a long time, nephrectomy is likely to bring about a cure. The outlook after operation in the case of women is better than that in men; 70 per cent of women are per-

manently well, but only about 40 per cent of the men. The disease is liable to appear clinically in the opposite kidney, because the lesions in the cortex have failed to clear up; or it may appear in the lungs, or in the genital tract in men. The operation should be not only a nephrectomy but, if possible, ureterectomy as well, as the prognosis is better when the ureter has been removed. After the operation, the great frequency of micturition is very much lessened; but some may persist, either because the bladder has become so contracted, or because of tuberculous ulcers within it. Once the kidney has been removed, however, tuberculosis of the bladder has a tendency to clear up. As a rule no treatment is required for this except attention to the general hygiene of the patient but, in cases of necessity, installations of 5 to 10 c.c. of guaiacol 2·5 gm., iodoform 1·5 gm., anaesthesin 1·5 gm., olive oil (sterile) 50 c.c. into the bladder give relief.

The tuberculous nephritis of the unaffected kidney soon disappears after the operation.

Abacterial Pyuria

This condition is sometimes seen in young men. It is an inflammation of the bladder and ureter and sometimes of the pelvis of the kidney. The patient complains of pain in the bladder, scalding and extreme frequency. Sometimes there is haematuria. There is no pyrexia. Cystoscopy reveals a much-diminished bladder capacity and diffuse inflammatory changes not particularly marked around the ureteric orifices. The urine contains pus.

The condition is very resistant to treatment but sometimes is cured by 0·3 gm. novarsenobenzol at weekly intervals for 4 weeks.

Renal and Ureteric Calculi

Urinary calculi are found in the kidney, the ureter, the bladder, the urethra or the prostate.

The conditions which lead to the formation of calculi are only very imperfectly known. The urine is a super-saturated solution of the uric acid, urates and the inorganic salts which it contains. If it were not for this many times the normal amount of urine would have to be secreted in 24 hours to get rid of the waste products of the body. It is supposed that the excess of these substances is adsorbed to the urochrome and other colloid substances in the urine. Such a state of balance between the colloid and the adsorbable constituents could very easily be upset by inflammation in the kidney, whereby the protective nature of the colloid would be lost and the salts deposited. A mild bacterial infection could do this, but it is to be noted that there

are many cases of renal calculi in which the urine is sterile; indeed this is the rule. Infection seems to be a complication rather than the originator of the condition in all so-called primary calculi. However, a mild infection which has been conquered by the body cannot be ruled out.

Hyperparathyroidism is associated with the depletion of the calcium stores of the body, that is, the bones, and is accompanied by an increase of the serum calcium and a diminution of the serum phosphorus. There is an increase of the calcium in the urine. Renal calculi often accompany the disease. Some other disturbances of metabolism are also associated with calculus formation, such as cystinuria. Phosphaturia not associated with infection is accompanied by an absolute and relative increase in the earthy phosphates in the urine and such patients are prone to suffer from stone in the kidney. Vitamin deficiency may play a part in the production of renal stones; particularly does experimental work point to deficiency in vitamin A as being a factor. For under this circumstance hyperplasia and keratinisation of the renal and vesical epithelium take place and may form starting points for calculus formation. Deficiency of this vitamin, as shown by night blindness, is present in a large proportion of patients with urinary calculi. The vitamin may not be deficient in the diet; so it is thought that there may be some difficulty in its absorption. The kidneys of many calculus bearers have deposits of calcium salts outside the basement membrane of the collecting tubules. Such patches are harmless if they remain in the connective tissue but the epithelium over them is apt to be shed, providing starting points for calculi. In animals again, hypervitaminosis D is associated with deposits of calcium salts in the kidneys, the walls of the heart and arteries. It is possible that hypervitaminosis occurs in human beings because the optimum therapeutic dose is very near to the toxic overdose. A high calcium diet also lowers the toxicity threshold for vitamin D.

When the urinary tract is infected with an organism which decomposes urea, such as the staphylococcus, the urine becomes alkaline and secondary phosphatic calculi are deposited. If there is already a stone present this will receive an outer chalky layer. It is particularly in such cases that stagnation of the urine plays such an important part, for example, when the prostate is enlarged, but it may also be a factor in primary calculi. For, when children are kept for long periods recumbent, as they are in the treatment of tuberculous joints, calculi quite frequently form. They appear in the lower major calyx. In the recumbent position gravity can play no part in the draining of urine from this part of the kidney.

There does not seem to be any evidence that the excessive sweat-

ing in hot climates predisposes to calculus. Stones are common in some parts of India, yet in other equally hot areas stones are rarely seen. In a similar way some parts of England are favourable to the formation of calculi, notably the eastern counties.

Many people pass crystals in the urine but they do not seem to be specially prone to calculus formation.

Every stone is a cluster of crystals supported on a scaffolding of colloid. This colloid is nearly always of the irreversible type; that is, it cannot be made to go again into solution in the urine. The exception to this is the calculi which form in children as the result of prolonged recumbency. Such calculi may be made to disappear by a diet of meat, fish and cereals, which cause the urine to be acid, assisted perhaps by the administration of ammonium chloride, which has the same action.

Whilst calculi are nearly always composed of a mixture of different chemical substances, one often predominates, so that we can speak of oxalic calculi composed of calcium oxalate, phosphatic calculi composed of the phosphates of calcium and magnesium, and uratic calculi composed of uric acid and the urates of sodium and potassium. In addition to these calculi there are found very rarely concretions made up of cystin, xanthine and of indigo. Oxalic stones are the commonest of all and they are sometimes called mulberry stones because they resemble this fruit in form. The surface of such stones is covered with sharp projections; they are very hard. On section they are dark in colour as a result of haemorrhage owing to their roughness and the decomposition of the haemoglobin into haematin. Oxalate stones occur in acid urine.

Phosphatic stones occur in two forms. There is a rare variety of oval stone, pure white with small mammilated surface. It is a glistening, crystalline structure and is laminated. This variety occurs in amphoteric or slightly alkaline urine. In frankly alkaline urine the phosphates are deposited in an amorphous form and, in contrast with the crystalline variety which is very hard, these stones are soft. They are actually like chalk in their physical properties. Such deposition of calcium carbonate and phosphate takes place very frequently on the outer surface of other varieties of calculi should infection of the urine with some organism which decomposes urea supervene. The organisms which do this are the staphylococcus and the proteus. The *Bacillus coli* does not cause the urine to become alkaline.

Stones composed of urates occur in acid urine. They are very often multiple. They have a fawn colour and a smooth, slightly mammilated surface; on section they are laminated.

It is a curious fact that in cases of bilateral renal stone the calculi on the opposite sides of the body may be composed of different constituents, and it is another curious fact that, on sectioning a large stone, it is sometimes found to have a nucleus of, say, calcium oxalate while superimposed upon it are layers of urates.

It has already been pointed out that most stones, except those the result of septic infection of the urine, probably arise in the renal



An oxalate bladder calculus: sectional and external appearances.



A uric bladder calculus in section.



A primary phosphatic calculus from bladder.



An oxalate bladder calculus surrounded by a layer of secondary phosphates.

collecting tubules. They are at first very minute (microcalculi) and are carried either into a calyx or the pelvis of the kidney. If they do not escape from the body in the stream of urine they increase in size and take on a very characteristic shape, that of a triangle with curved sides or a crescent. Such a shadow in an X-ray is very characteristic of a pelvic stone. As the calculus increases in size it grows out into the ramifications of the renal pelvis so that finally it forms an exact cast of this structure (the branching coral-like stone).

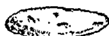
The stone, while it is still small and, in general, spherical in shape, may pass down the ureter and be voided by the urine but it may be very much delayed in its passage down this tube. In fact it may remain there for many months. During this time it is likely to increase in size; it changes its shape and becomes an elongated ellipsoid just like a date stone. Such a shadow in the line of the ureter is characteristic of a ureteric stone. Should a stone gain access to the bladder it again takes on a characteristic shape. It produces an oval shadow on X-ray examination and the shadow lies with the long axis horizontally within the pelvis.

The kidney cannot harbour a calculus for long without becoming damaged. Should it remain aseptic, a chronic interstitial nephritis is set up which ultimately interferes with kidney function. Indeed

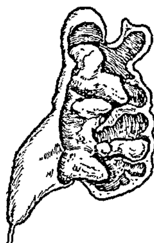
the large branching calculi sometimes lead to the disappearance of all the renal secreting tissues and remain finally invested with a fibrous tissue layer derived from the renal capsule and interstitial tissue. Occasionally an aseptic stone will set up a *reaction in the neighbourhood* so that lipomatous tissue results. The kidney is replaced by a lipoma in the middle of which is situated the kidney pelvis containing the stone.



A large branched renal calculus.



A ureteric calculus.



A large calculus inside a kidney shrunken to a fibrous bag. All the parenchyma has disappeared.

A *calculus is very likely to become impacted* in the uretero-pelvic junction and lead to the formation of a hydronephrosis. Stagnation of urine predisposes to *infection* so that it is quite common for the hydro*nephrosis to be converted into a pyo*nephrosis. A septic nephritis may spread from the kidney into the surrounding tissues with the formation of a perinephric abscess. Stones which lodge in the ureter *may, of course, give rise to similar* changes in the kidney, but curiously enough there is *often no dilatation.* This is because either, owing to irregularities in the shape of the stone, there is sufficient room for the urine to pass by, or, as is sometimes seen, there is actually a groove down one side of the stone which acts as a channel for the passage of the water.

Renal calculi are frequently bilateral, and large branched stones present on both sides of the body may ultimately lead to so much destruction of the kidney tissue that uraemia results.

Symptoms. — The most characteristic symptom of stone in the kidney is renal colic. This is a pain which begins in the loin in the angle between the twelfth rib and the outer margin of the erector spinae (renal angle) and extends round the flank of the abdomen down the corresponding side to the groin and into the labium or testis. The pain is also felt *on the outer side of the thigh* where it is referred along the iliac branches of the ilio-inguinal and ilio-hypogastric nerves. This is an important point because abdominal lesions do not give rise

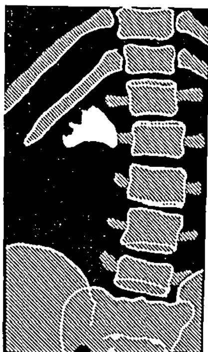
to pain in that situation. Very occasionally the pain is felt down the leg, especially in the region of the lateral malleolus. Although it radiates round the back it never goes up towards the shoulder as biliary colic does. The pain waxes and wanes in intensity like any other colic, and it may extend all over the abdomen so that it is difficult to say on which side it is. Very occasionally also the pain is referred to the opposite healthy kidney. The abdominal muscles are held in spasm. The kidney, either because of congestion or the damming-back of urine within the pelvis, is increased in size and always palpable if the abdominal muscles can be made to relax. There is great tenderness in the renal angle behind. This distension of the renal capsule, reflexly through the renal plexus, may cause an inhibition of all intestinal movement; so that the abdomen becomes distended. The condition resembles very much one of intestinal obstruction. During the attack of pain there may occur strangury, that is, repeated painful efforts at emptying the bladder, but only small quantities of urine are expressed. There may even be complete anuria. The pain often ceases abruptly, either because the stone passes down the ureter and enters the bladder or falls back into the pelvis of the kidney, thus relieving the tension. Hyperaesthesia of the testis and renal tenderness remain for some hours after the pain has gone.

Renal colic can only occur when the stone is movable and small enough to block the uretero-pelvic junction. Large fixed stones give rise to a dull ache in the region of the kidney which is made worse by exercise or the shaking of a train or bus. The kidney in this case is nearly always tender on compression. Some stones are so fixed and cause so little irritation of the kidney that the patient is quite unaware of their existence. As far as symptoms go, they are completely silent and only revealed when some small accident causes a haemorrhage to occur.

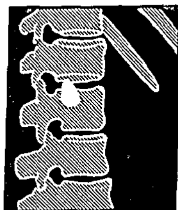
Haematuria is the other great sign of stone in the kidney. It may on its first appearance be profuse. It never absolutely fails in an attack of renal colic, though the blood corpuscles may be only seen on a microscopic examination. The haematuria due to a stone is preceded by colic, whereas that due to a growth of the kidney occurs before the onset of the pain, this latter being due to the passage of clots down the ureter. The temperature is often raised during an attack of renal colic. If a small stone passes down the ureter, as soon as it emerges into the bladder the colic disappears. Such stones are often passed in the urine without any particular pain. They usually do so in women.

The diagnosis of renal stone is rendered certain by the demonstration of the stone by X-rays, but it must be remembered that

some stones fail to throw a shadow. This is true of pure uric acid stones. In such cases other methods of examination may give the clue, particularly the demonstration of the shape of the renal pelvis by the injection of uroselectan when a hiatus in the shadow reveals the presence of a stone; or perhaps the passage of a ureteric bougie may give some indication of an obstruction in the ureter. The characteristic shape of a stone in the pelvis of the kidney is a triangle with curved sides,



Stone in renal pelvis. The shape is quite characteristic.



Stone in pelvis of kidney: in lateral view it lies over the bodies of the vertebrae.

or a crescent. Branched calculi are easily recognisable. Calculi in the ureter are rounded, sometimes irregular in shape, or if they have been there for a long time, elongated.

Treatment.—During an attack of colic, bed and warm applications give some relief. Morphine or, better, papaverine (1 grain by mouth) help to relax the ureter and facilitate the passage of the stone. As a rule it may be said that the demonstration of a stone in the kidney calls for its removal, but there are some exceptions to this rule. If the stone is very small and lies at the extremity of a calyx and is fixed so that it does not produce symptoms, it may be wiser to leave it, particularly if the patient is fat and his kidney inaccessible. When there are bilateral, aseptic, large, branched calculi, which have caused the destruction of much secreting tissue, it is also sometimes better not to remove the stones. Operation is imperative if there is a hydronephrosis or infection is present.

Stones in the kidney are removed by an oblique incision beginning in the renal angle behind and extending forwards to about 1 inch above the anterior superior spine of the ilium. The kidney is exposed behind the peritoneum. The stone may be extracted through an

opening in the pelvis of the kidney (pyelolithotomy) or by an incision in the kidney substance (nephrolithotomy). The position of the stone within the kidney should be accurately known before the operation. It is determined by pyelographic examination. Stones in the pelvis of the kidney are removed by a simple incision of this structure on its posterior aspect away from the renal vessels.



A stone in the ureter. An opaque catheter has been passed up the ureter as far as the calculus.

A stone in the substance of the kidney in reality lies at the extremity of a calyx, usually a lower calyx. Its position having been determined by pyelography, an opening is made in the pelvis and a curved probe inserted until it makes contact with the stone at the extremity of the calyx. When this has been done, a small incision through the kidney substance is made on to the end of the probe and the stone extracted. Exploratory incision of the kidney and needling are now never used in the search for a stone. Unless the opening in the pelvis of the kidney is large, healing takes place more quickly if no sutures are inserted. A drainage tube should always be left in the wound.

When there are bilateral stones the calculus is removed from the less damaged kidney first.

Ureteric Stones

The origin and form of ureteric stones have already been discussed. It was pointed out that for a stone to be able to enter the ureter it must be of small size, so that it is not surprising that the majority of these calculi pass right down the length of the ureter and reach the bladder. A small number of them get held up either at one of the narrow points in the ureter, that is, the upper end, the lower end or the point where the ureter crosses the brim of the pelvis, or their irregular surface catches in the mucosa of the tube and so leads to their impaction. A stone may lie in the ureter for many months, giving rise to repeated attacks of renal colic, one of which finally causes its expulsion. Whilst within the ureter the concretion may be added to, when it assumes the characteristic date-stone form. It has already been pointed out that a stone lodged in the ureter may still allow the passage of urine past it, either because there is a longitudinal groove down one side, or because of its irregular shape.

The symptoms of ureteric stone are those of renal calculus, but when the stone reaches the lower end of the ureter, it is apt to cause symptoms referable to the rectum, a burning or tenesmus. In the female the lower end of the ureter is palpable at the side of the lateral fornix of the vagina. If a stone is impacted in this situation it can be felt by vaginal examination. Complications of stone in the ureter are hydronephrosis, infection and, possibly, anuria. This calculus anuria occurs when one ureter is completely blocked by a stone whilst the other kidney is either absent, been destroyed by disease, or has its ureter also blocked by a stone. Sometimes there is a short-lasting anuria, when, with a stone in one ureter, the opposite kidney is healthy. This is a reflex nervous anuria which soon disappears of its own accord.

Treatment of Ureteric Stone.—Since so many ureteric stones pass into the bladder as a result of attacks of renal colic, operative removal is only required in the minority of cases; but measures should be taken to assist the passage of the stone. Such measures are the drinking of large quantities of liquid, the administration of papaverine and cystoscopic manipulation. If a stone on cystoscopy is seen to be at the very lowest end of the ureter projecting from its mouth, it is sometimes possible to grasp it with a pair of forceps passed through an operating cystoscope. Removal by this means is often impossible because the stone is too firmly impacted; in which case the opening of the ureter can be enlarged by an incision, if it is possible to insert the blade of a small knife between the stone and the ureteric wall, or by dividing the ureteric mouth with the fulgurating electrode. The drawback to this latter method is that it may be followed by a scarring and contraction at the ureteric orifice. When a stone impacted in this position refuses to pass, it is sometimes better to open the bladder above the pubes and incise the aperture with an ordinary scalpel. Occasionally, manipulation with a ureteric catheter will dislodge the stone, perhaps backwards again into the pelvis, when the catheter should be left *in situ* for 24 or 48 hours.

When the stone is seen by the X-ray to be in the course of the ureter, a ureteric catheter should always be passed. If possible slide it into the lumen of the ureter above. Such simple manipulation may cause the stone to pass by, dislodging it from a fold of the mucosa. If two small catheters can be passed up beside the stone, by twisting them round each other, the stone may become entangled, when it can be slowly dragged out of the ureter. A catheter passing beside a stone and allowed to remain in the ureter for 48 hours will cause the channel to dilate and its withdrawal will very often be followed by the passage of the stone. A small stone within the bladder is sometimes

passed naturally, more especially in the case of women, but if it is not, it can be crushed with a lithotrite and the powder sucked out through an evacuator.

An impacted ureteric stone should always be removed by an open operation if there is infection of the urinary tract, if there is a hydronephrosis behind it, or if the stone is more than one centimetre in diameter. Stones in the upper end of the ureter, or in its middle course, are removed by an ilio-lumbar incision with the pushing forwards of the peritoneum very similar to the approach to the kidney itself. If the stone is impacted within a centimetre or two of the bladder, it is very inaccessible. A good way to reach it here is to make a suprapubic mid-line incision and push the peritoneum off the bladder on one side until the lower end of the ureter is exposed in the depth of the wound. In women it must be remembered that the ureter in the lower part of its course lies beneath the uterine artery and above the uterine plexus of veins. In order to get proper access to this part of the ureter, it may be necessary to divide the uterine artery between ligatures. The wounds made in the ureter for the extraction of stones heal very well without suturing unless they are large, when it is better to approximate them with one or two fine catgut stitches. A drainage tube must always be inserted down to the site of the operation.

In calculus anuria the attack is ushered in by renal colic. On its cessation the patient notices that he is passing no urine at all. He may feel quite well and go about his ordinary business in life except for this remarkable circumstance. At the end of about 6 days, serious symptoms occur. He has headache and perhaps wanders in his sleep. He has some breathlessness and is physically weak. He passes into an apathetic state with very weak pulse and, without any convulsions, lapses into coma and dies.

When calculus anuria is suspected, an X-ray photograph should be taken without delay in order to determine the existence of a calculus and its site of impaction. If it should be in the ureter, immediate relief may be given by the passage of a ureteric catheter, but this should only be regarded as a very temporary measure. As soon as preparations can be reasonably made, the calculus should be removed by an open operation.

Tumours of the Kidney

Innocent tumours are rare and of no clinical importance. They are small adenomata, lipomata, or fibromata, found in the substance of the kidney.

If a tumour gives rise to clinical symptoms it is certainly malignant. Malignant tumours found in the kidney are strikingly different in adults and children. In the latter mixed tumours occur; in adults the growth may be a simple infiltrating carcinoma or a Grawitz tumour.

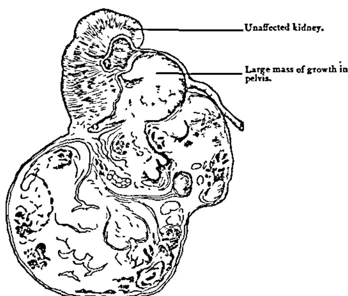
Mixed Tumours of Children

These tumours occur in children, usually within the first three years of life; they may even be present at birth; they are situated more often in the lower than the upper pole of the kidney and occasionally are bilateral; they have a capsule. On section there is a ground substance of connective tissue which may include sarcomatous tissue, cartilage, myxomatous tissue, smooth or striped muscle fibres and epithelial elements in masses or tubules. The growth of these tumours is very rapid but metastasis occurs in only one-third of the cases. On the other hand, after removal, local recurrence is very common, so that the prognosis, after operation, is extremely bad. The first warning of this disease in children is usually the discovery of a tumour within the abdomen. It does not seem to be associated with any pain and, as a rule, there is no haematuria. The growth may get to such a size that it forms a visible bulge of the abdomen in front, and presses the lower ribs outwards at the side. The pushing-up of the diaphragm with embarrassment of its movement leads to dyspnoea. The superficial veins on the abdomen are enlarged and there may be oedema of the lungs from pressure on the vena cava, and very often ascites. The child looks extremely pale and ill. A remittent temperature is present. The course of the disease is a rapid one and the only hope is surgical removal of the tumour. Although the outlook is bad, a certain number of the children recover and remain well; it must be confessed, though, that as a rule they die within a year.

Tumours in Adults

The tumours found in adults are the infiltrating carcinoma and the Grawitz growths. The former is a simple carcinoma which quickly spreads throughout the kidney. It early gives rise to metastases in the neighbouring glands, and breaks through the capsule into the surrounding parts. The Grawitz tumour is at first localised, forming a nodule more often in the middle or the lower part of the kidney than in the upper pole. This tumour forms 80 per cent of all neoplasms of the kidney; it is yellowish in colour and often has haemorrhages within it. In structure it resembles rather closely that

of the suprarenal gland and was, at one time, thought to develop from suprarenal rests which are sometimes found within the kidney substance. However, this view is untenable for several reasons: it is more common in the lower part of the kidney than in the upper pole; and it does not give rise to the sex changes which hypertrophy of the suprarenal gland does. It has a similarity in appearance but not a similarity in origin. The tumour must be regarded as a variety of carcinoma arising from the kidney substance. It does not occur in children; it is seen in adults over 40 years of age. It spreads to the lymphatic glands in the neighbourhood, but has a great tendency to invade the renal veins and form distant metastases. These are



Hypernephroma of kidney.

found in the lungs, where they form circular-shaped shadows, and in the bones, where they are likely to give rise to pathological fractures.

The characteristic symptom of carcinoma of the kidney is painless haematuria which is intermittent. The haemorrhage may last for a few hours or a number of days, but it stops, and between such attacks the urine is quite clear and free from blood. During the attack the intimate mixture of the blood with the urine, and its brownish colour from the transformation of some of the haemoglobin into acid haematin, is suggestive of its origin from the kidney. Should blood collect in the pelvis of the kidney and clot there, the passage of such clots down the ureter may be accompanied by renal colic, and the worm-like coagula, so shaped by the ureter, are sometimes seen in the urine. It is to be noted that, with a tumour of the kidney, colic follows the

haematuria; whereas, with a calculus, colic precedes the bleeding. As the tumour grows large and distends the capsule of the kidney, it may cause a dull aching pain in the loin. When it has grown sufficiently, the renal tumour becomes palpable. These tumours are extremely well supplied with blood, form vascular connections with the perirenal tissues, and sometimes cause a varicocele to develop. A varicocele coming on in a man over 40, particularly on the right side, should give rise to the suspicion of a renal tumour. As the tumour increases in size, absorption of its products of metabolism causes loss of strength, appetite and weight. There is frequently an irregular fever present. The diagnosis is made by the presence of painless haematuria associated with a renal tumour. The tumour, however, may be impossible to feel, in which case pyelography may demonstrate its presence. Intravenous pyelography will usually do this. The nodules of the tumour press into the pelvis and form curved indentations of its shadow and are apt to separate the calices from the pelvis so that the necks of the calices become dragged out into long structures; or perhaps some of them fail to fill. A spider-like formation in the pyelographic shadow results. The intravenous method may sometimes fail to give any shadow on the affected side; then an ascending pyelogram should be made. If on cystoscopy and the passage of a ureteric catheter, blood immediately pours out of the catheter, it is suggestive of a renal tumour. Such bleeding will often cause a stoppage in the ureteric catheter by clotting and defeat the object of the examination. Cystoscopy is necessary to prove the presence of another kidney unless an intravenous pyelogram proved such a kidney to be present and healthy. Occasionally the first sign of a Grawitz tumour is a pathological fracture of one of the long bones. Curiously enough, such a metastasis may be single and remain unique for several years, so that it is sometimes right treatment to remove it as well as the primary growth. Before contemplating an operation on a Grawitz tumour, an X-ray photograph of the chest should be taken to exclude secondary growths in the lungs.



Pyelogram of a Grawitz tumour of the kidney.

The treatment of carcinoma of the kidney, other conditions being favourable, is nephrectomy. If this should not give a permanent

cure, it is calculated to relieve the patient for a number of years. In carrying out the operation, the great tendency to invade the renal vein should be borne in mind. On several occasions a growth projecting into the vena cava has actually been removed with success.

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stream. Urethral infections come as a rule from microbes carried up by instruments; but it must be remembered, that in women the whole of the normal urethra may harbour organisms up to the internal sphincter, and that spontaneously they may multiply and grow along the surface of the mucous membrane, and actually pass through the sphincter to the bladder; in men there are many bacteria in the fossa navicularis but the number of organisms diminishes until the compressor urethrae are reached; above this the posterior urethra is sterile, so that the bladder in men is more protected than in women. When there is a urethritis, however, bacteria may grow along the urethra into the bladder just as in women they do. Most spontaneous cystitis is a descending infection from the kidneys. The lymphatic infection takes place when there is a septic focus in the neighbourhood: pelvic appendicitis, salpingitis, parametritis, inflamed haemorrhoids and fissures.

The bladder mucosa is very resistant to infection; pus may pour into the bladder from the kidneys without cystitis resulting, or an abscess burst into the bladder, and the area of inflammation be confined to the immediate surroundings of the fistula. But this insusceptibility of the bladder is much lowered when there is an injury to the mucosa from instrumentation or the presence of stones, or there is stagnation of the urine, or there is a hyperaemia caused by constipation, pregnancy, the existence of a neighbouring inflammation or otherwise.

The organisms chiefly met with are the *Bacillus coli*, the staphylococcus or the streptococcus; other bacteria not so commonly found are the gonococcus, the pneumococcus, the proteus, typhoid, Friedlander, pyocyaneus or pseudophtheroid bacillus. The mucosa becomes hyperaemic, loses its yellow colour, and with the cystoscope looks uniformly red, without any separate vessels being discernible; there may be shallow ulcers, haemorrhagic patches, inflammatory nodules or oedematous bullae.

The symptoms are those of irritability of the bladder. There is a frequent desire to empty the bladder which becomes very urgent: so compelling that the patient may not be able to get out of bed quickly enough before the sphincter gives way and the urine is expelled. The effort is associated with so much pain, which is worse at the end of the act, that the patient stops before the bladder is quite empty. As the walls of the bladder, from urinary infiltration, are rigid and inextensible, this means that micturition becomes very frequent, and the patient's rest is very seriously disturbed. The bladder is sensitive to palpation from the vagina or rectum; the mucous membrane is also extremely tender to the impact of an instrument. The urine always contains pus, and often blood which is

CHAPTER XLVIII

DISEASES OF THE BLADDER

Exstrophy of the Bladder

Exstrophy of the bladder, or ectopia vesicae, is a very rare defect of development in which the anterior wall of the bladder and abdomen fail to fold in properly from each side; the posterior wall of the bladder is flush with the surface, or even projects somewhat, the ureteric openings visibly discharging their intermittent trickles of urine. There is a defect of the bony pelvis in front; and in the male, in whom the deformity is the more common, epispadias exists, leading down to a minute sessile glans penis. The existence of such individuals is truly pitiable; they do not usually live beyond 20 years of age, succumbing, as a rule, to an ascending pyelitis. An operation should be done about 4 or 5 years, but not if both kidneys are infected, which may be determined by catheterising both ureters. The standard operation to-day is the transplantation of the ureters into the sigmoid, one at a time. This is done by opening the peritoneum, and in such a way that the ureters run for some distance between the muscle coat and the mucosa, so that a valvular opening is made, which is found to afford some protection from an ascending infection. After this procedure the patient learns to retain the urine in the rectum and may live for many years an apparently healthy life. Another good way is to free the ureters separately with a little disc of surrounding mucosa, taking care to do as little dissection of the ureters as possible, in order to preserve as much as can be done the nerve supply, and to transplant them extraperitoneally into the anterior wall of the rectum. Hampton Young has had some success by dissecting out the internal sphincter of the bladder which he claims is existent but unfolded, and suturing the ends together to form a ring. The sides of the bladder are then turned in and a closed cavity constituted.

Inflammation of the Bladder

Cystitis may come from an infection spreading up from the urethra, descending from the kidney, or being conveyed by the lymph

stream. Urethral infections come as a rule from microbes carried up by instruments; but it must be remembered, that in women the whole of the normal urethra may harbour organisms up to the internal sphincter, and that spontaneously they may multiply and grow along the surface of the mucous membrane, and actually pass through the sphincter to the bladder; in men there are many bacteria in the fossa navicularis but the number of organisms diminishes until the compressor urethrae are reached; above this the posterior urethra is sterile, so that the bladder in men is more protected than in women. When there is a urethritis, however, bacteria may grow along the urethra into the bladder just as in women they do. Most spontaneous cystitis is a descending infection from the kidneys. The lymphatic infection takes place when there is a septic focus in the neighbourhood: pelvic appendicitis, salpingitis, parametritis, inflamed haemorrhoids and fissures.

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squeezed out at the end of micturition. If there are urea-splitting organisms present such as the *staphyloccus*, the urine is strongly alkaline with a foul ammoniacal smell. The *Bacillus coli* cannot hydrolyse urea, so that the urine, with this organism, is acid. As the bladder mucosa has very slight absorptive powers there is often but little fever or other sign of constitutional disturbance.

The diagnosis is usually easy but it must always be remembered that cystitis is very often a complication of some other urinary condition (stone, enlarged prostate, etc.); increased frequency may occur without pyuria in phosphaturia, a hypertrophied prostate and other conditions, whilst increased frequency with pyuria are also found in pyelitis, benign or tuberculous. Cystoscopy should never be done in the acute stage, but may give valuable information when the condition becomes chronic.

An acute cystitis beginning in an otherwise normal bladder has a tendency to clear up spontaneously. Rest in bed is necessary and a light diet should be given with plenty of liquids of a bland nature such as barley water. The bladder pain may be relieved by hot fomentations on the hypogastrium, and if necessary, by suppositories of morphia and belladonna, or even by morphia hypodermically. Potassium citrate in 20-grain doses in a mixture often gives relief. No local treatment is desirable in the early acute stages. After a few days if the symptoms persist, an instillation daily of 5-10 c.c. of collargol solution may help. If the bladder will tolerate it, daily irrigations with 1 in 10,000 oxycyanate of mercury are indicated; not more than 2 oz. should be introduced at a time because of the small capacity of the bladder.

For a *Bacillus coli* infection a course of sulphadiazine or sulphathiazol should be given. If this fails mandelic acid should be tried (page 680). When the infecting organism is susceptible to penicillin a course of this drug is indicated.

Cystitis which is associated with one of the conditions mentioned above as predisposing factors is much more resistant to treatment and may be quite incurable until the circumstances favouring infection have been rendered inoperative.

Encrusted Cystitis

This is a chronic ulcerative cystitis which is characterised by the deposition of chalky deposits on the wall of the bladder. The urine is strongly alkaline, due to the activity of *B. proteus ammoniae*. The urine coming from the ureters may be acid. There are great frequency, pain, haematuria and pyuria. The bladder becomes very contracted.

The condition is exceedingly intractable. Suprapubic cystotomy, scraping the bladder incrustations away and painting the raw areas with silver nitrate, may be necessary, but a few favourable results have been obtained by prolonged daily irrigations of the bladder with acid (acetic acid B.P. 2 drachms to the pint). It is worth trying the following solution which has been used for dissolving renal phosphatic calculi and those made of carbonates: citric acid (monohydrate) 32·25 gm.; anhydrous magnesium oxide 3·84 gm.; anhydrous sodium carbonate 4·37 gm.; water up to 1000 c.c. Intermittent irrigation with this should be carried out for 10 hours a day for which a simple tidal drainage syphoning apparatus is used. The solution is known as solution G.

Diverticula of the Bladder

Acquired sacculation of the bladder occurs when there is some obstruction in the urethra: an enlarged prostate or a fibrous stricture. These diverticula are multiple, and situated in any part of the bladder except the trigone. They are really herniations of the mucous membrane through the muscle coat; for they have muscular tissue in their walls only around the entrance into the bladder. They do not require any special treatment but the primary obstructing lesion should be corrected.

Congenital diverticula are found close to the openings of the ureters and are thus sometimes bilateral; they also occur on the front wall of the bladder where they are the remains of the urachus. Unlike acquired sacculations they have a proper muscular coat, which, at the orifice, has a sphincter action. It is because of this that the patient micturates in two acts; at the first he empties the urine in the bladder in a strong stream; at the second, almost immediately after, owing to the relaxation of its sphincter, the diverticulum contents are discharged in a weak stream. Usually the second act is accompanied by some bladder pain, the contents of the diverticulum being septic; indeed it is usually this sepsis that makes the patient seek assistance. Although the deformity is a congenital one, the patients are seen clinically in middle life, when the musculature of the diverticulum is weakening, and stagnation of the contents predisposes to infection. Prostatic obstruction may determine the onset of symptoms. Infection may pass up to the kidney and cause pyelonephritis, particularly as the diverticulum often presses upon the ureter and obstructs it. A calculus may form in a diverticulum.

When a history of micturition in two stages is obtained, a diverticulum of the bladder should be suspected, and cystoscopy performed.

This will reveal the opening of the sac, situated as a rule near the mouth of the ureter. The size of the diverticulum is best demonstrated by filling the bladder with 13 per cent sodium iodide solution, and taking an X-ray photograph; an oblique view will show the bladder cavity and the diverticulum; if the patient be now made to perform the first stage of micturition, and another photograph taken, the diverticulum will be seen alone; a similar picture can be obtained if, at the cystoscopy, a ureteric catheter is left in the diverticulum and the bladder emptied, so that the diverticulum itself can be filled directly with the contrast medium.

The mortality from an infected diverticulum is very high, so that these patients should always be operated upon. The best way is to strip the peritoneum off the surface of the bladder so as to expose the diverticulum from without. Its isolation may be facilitated by opening the bladder and distending the diverticulum with gauze. Care must be taken not to injure the ureter. The neck is isolated and the sac removed; the hole in the bladder is sutured. Small diverticula are sometimes removed from within the bladder by first cutting round the neck and then gradually dissecting the sac from its surroundings by this route. When there is an enlarged prostate both the diverticulum and the prostate may be removed at the same time, but should this be thought to impose too great a strain upon the patient, the diverticulum should be removed first and the enucleation of the prostate carried out on some future occasion.

Injuries of the Bladder

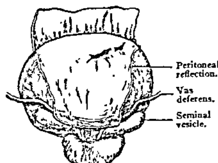
Under this heading must be included (1) wounds, and (2) rupture of the bladder from a sudden rise of pressure of its contents.

Wounds occur by stabbing, shooting, falling on a spike, in operations, and occasionally from forcible use of a catheter which may actually perforate the bladder wall from within. The operations likely to be associated with an injury to the bladder are the removal of the uterus or the rectum, a herniotomy or the enucleation of tumours adherent in the pelvis. If such an injury be noticed at the time of the operation, and the wound be sutured, there is usually no bad consequence; but if the wall of the bladder is only damaged, so that an area subsequently necroses, then there may be all the evil results of extravasation of urine.

Rupture of the bladder takes place nearly always when the organ is distended. It is due to a blow on the abdomen or a fall. It is fairly common in motor-car accidents; but it is surprising how slight a force may be sufficient to cause a rupture, especially if the bladder

wall be diseased and weakened by inflammation, or atrophied by disease of the spinal cord. After litholapaxy, forcible distension of the inflamed bladder by the evacuator has been known to burst it. A high proportion of the patients have been drunk when the accident occurred; they are insensitive to their distended bladders, and the relaxed abdominal muscles do not afford the usual protection to the viscera. Spontaneous rupture never occurs with a healthy bladder; but with one whose walls are weakened by disease, parturition, the lifting of a heavy weight, or even overstretching due to holding the urine too long, may lead to it.

The tear in the bladder is more often longitudinal than transverse when it is due to simple bursting, and is situated on the peritoneal surface. Although an extraperitoneal rupture may take place, this injury is more often associated with a fracture of the pelvis where a jagged broken surface of bone has torn through the bladder wall.



Intraperitoneal rupture of the bladder from behind.

Rupture of the bladder is always followed immediately by severe shock and an intense desire to pass urine, with the power only to force out a few drops which are blood-stained. After this, in spite apparently of retention of urine, no bladder tumour rises up above the pubes; the dulness of a normally filled bladder is wanting. Soon there will be either signs of infiltration of the cellular tissue of the pelvis with urine, in an extraperitoneal lesion, or evidence of the escape of the urine into the abdominal cavity. In the former, if the urine is septic there quickly appears the cellulitis with gangrene characteristic of extravasation of urine; or a little later if the urine is aseptic (page 748). In the latter there are signs of free fluid in the peritoneum, with distension of the intestines. Should the urine be infected, there are the signs of septic peritonitis; but should it be aseptic, absorption of the urine may lead to the appearance of the symptoms of uraemia: sallow grey face, dry coated tongue, small pupils, twitchings of the hands or the face muscles, drowsiness and finally coma.

The above symptoms should make the diagnosis clear. It is advisable, if possible, to avoid the passage of a catheter, as this may introduce sepsis. If a catheter must be passed, it will withdraw only a small volume of blood-stained urine; and if a measured quantity of liquid is introduced, but a fraction of it can be recovered.

Treatment is urgent. A suprapubic incision must be made. An extraperitoneal rupture should be partly sewn up and a drainage tube

left in the bladder; for the suture of an intraperitoneal rupture the abdominal cavity must be opened: in this case also it is better, after suture, to drain the bladder suprapubically than to tie in a catheter.

Foreign Bodies in the Bladder

These mostly gain entrance by the urethra. Lunatics and children sometimes insert objects into the urethra which slip in beyond their reach. An instrument intended to effect an abortion may also be lost in this way. Foreign bodies are indeed more often found in the female than the male bladder. The end of a catheter may break off and remain inside. Penetrating injuries can leave splinters behind. An abscess may rupture into the bladder, and allow the entrance of a bone sequestrum in osteomyelitis of the pelvis, or a fruit stone or other object from the bowel when the abscess has resulted from appendicitis or diverticulitis.

The symptoms are increased frequency of micturition, strangury and haematuria. The urine is nearly always septic and alkaline. Such bodies should always be removed. Small objects can be extracted by instruments passed through the operating cystoscope, but usually it is necessary to perform a suprapubic cystotomy.

Vesical Calculus

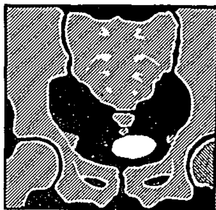
Calculi in the bladder are not as common as they were in former days, although during the last few years they have become much less rare, not only in a great part of middle Europe, but to some extent also in this country. They are less often seen in women than in men; probably because the urethra in women is larger in calibre, and shorter, than in men, and so allows calculi to pass.

The cause of calculi in general has been discussed on page 686. Like renal calculi they are primary or secondary. While the majority of primary vesical calculi come down from the kidney, it is possible that some of them form in the bladder itself. In shape, a vesical calculus is usually ellipsoidal with the long axis horizontal; the surface is smooth unless the calculus is made of calcium oxalate, when it may be very rough. Secondary calculi are the result of infection with some organism such as the staphylococcus, which decomposes urea, and are composed of an amorphous white mass of calcium carbonate and phosphate. Such calculi form around foreign bodies in the bladder when there is infection, and in cases of enlargement of the prostate and diverticulum, where there is stagnation of the urine.

It is very curious that a large calculus can exist in the bladder

without there being any symptoms at all. Usually, however, a stone causes haemorrhage and pain. The bleeding comes on with exercise, and at the end of micturition when the bladder wall contracts down on the stone; it is never massive as is the haemorrhage of tumour. The jolting of riding in a vehicle may cause great pain; with such calculi patients walk about very gently on their toes. The pain at the end of micturition is felt at the tip of the penis, and also sometimes in the rectum. When the pain on micturition is very severe the patient will often stop the act before the bladder is empty; so that there is residual urine left, and the chance of septic infection is great. The mechanical irritation of the bladder wall leads to hyperaemia and frequency, and itself predisposes to infection. Sometimes a stone becomes wedged in the internal meatus and causes retention of urine; or more rarely, owing to its irregularity, it holds open the meatus and leads to incontinence. The frequency, the pain and the haematuria of an uninfected vesical stone are all lessened by rest in bed, and increased by activity. When infection comes on, the severity of the pain and the frequency are much increased. The spread of it to the kidney sets up a pyelonephritis which may bring about the death of the patient. The diagnosis of stone is confirmed by radiography and cystoscopy. The shadow thrown by a vesical calculus is situated in the pelvis, and is typically oval in shape with the long axis horizontal.

The removal of stones in the bladder is carried out in two ways: the calculus may be crushed in the bladder with an instrument called a lithotrite, after which the powder in the bladder is sucked out by an evacuator, the operation being controlled with the cystoscope; or an incision is made into the bladder above the pubes for its extraction.



Stone in bladder: characteristic horizontal oval shadow.

Litholapaxy, as the former operation is called, can be done only when the urethra is large enough to allow the instrument to pass, and when there is no infection. It is therefore ruled out in young children, or when there is an enlargement of the prostate, or a stricture of the urethra. The advantage of litholapaxy is that the patient is confined to bed for a day or two only. There are no serious risks when it is carried out skilfully. In enlargement of the prostate the obstruction to the urethra should be removed, the extraction of the stone being but an incident in this operation.

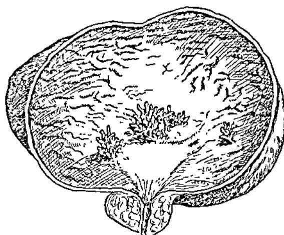
Tumours of the Bladder

The tumours found in the bladder are papillomata, carcinomata and, very rarely, sarcomata. Tumour formation is predisposed to by chronic cystitis, stone, bilharzia and certain aniline dyes.

Papillomata

Papillomata occur at a rather younger age than carcinomata. They are fimbriated tumours with a stalk which is usually slender, but sometimes rather thick. At first they grow slowly but after a time they take on a much more rapid increase in size. They do actually seem to become carcinomatous, the malignant change taking place where the stalk joins the mucosa of the bladder. Another characteristic is that fragments of these growths are liable to break off and implant themselves in the mucous membrane, thereby starting new tumours.

The chief symptom is haematuria which is painless and profuse. After the first bleeding there may be no further evidence of anything being wrong until an interval of months or even years has elapsed. Then bleeding comes on again and is repeated; the intervals becoming shorter and shorter, until it is continuous. Between the haemorrhages the urine is quite clear and normal in composition, except when the papilloma has become large; in this case it may contain albumen up to as much as 10 per cent, due to a serous transudation from the tumour itself, the kidneys being quite healthy. Sometimes a papilloma will block the internal meatus and interfere with micturition; at other times, when it is near the opening of the ureter, by traction, it causes obstruction, and leads to hydronephrosis. Sooner or later infection occurs with pain, frequency, and all the serious consequences to the kidney.



Papillomata in the bladder.

Painless haematuria always means that cystoscopy must be done. A papilloma is recognised by its long finger-like processes, in which actual blood-vessels can be seen pulsating. Although the patient may be very anaemic, he very rarely dies from loss of blood; he usually

succumbs to pyelonephritis, the anaemia of course contributing by making him more susceptible to infection.

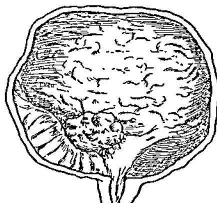
When the papilloma is small, it should be destroyed by diathermy, the electrode being passed through the cystoscope. It may have to be done in several sittings at intervals of two to three weeks. Several papillomata, if small, can be got rid of in the same way; but if the tumour is very large, or there are multiple growths, it is better to open the bladder above the pubes, and remove them by the cautery or knife. In doing this, great care must be taken not to implant any of the tumour cells on the surface of the wound or there will be a recurrence in the scar.

If, in fulgurating a papilloma of the bladder in several sittings, no progress is made in getting rid of it, the suspicion is aroused that the growth has become malignant.

Carcinoma

Carcinoma is met with in two varieties: (1) papillary, and (2) infiltrating.

The papillary form is rounder and has a broader base than the benign papilloma; it is not sharply demarcated off from the normal bladder mucosa; around its stalk there is some oedema or reddening of the bladder wall; the tumour is not so easily moved to one side with the cystoscope, as a simple growth; its surface is almost certainly ulcerated, and sloughing.



Carcimona of bladder.

The infiltrating form causes a reddening and thickening of the wall of the bladder. At the beginning it may be a little difficult to be certain that it is not a patch of chronic cystitis. Secondary growths are found in the pelvic lymphatic glands, liver and lungs. Such metastases are not common in the papillary type because the patient usually dies from infection before they can take place.

The symptoms of carcinoma of the bladder are very similar to those of papilloma, but they develop more quickly and the increased frequency of micturition is accentuated, because the bladder wall is infiltrated and unable to distend much; sepsis and pain come on earlier. Death takes place from infection in one to two years.

The diagnosis is usually easy by cystoscopy, except in the few

cases where the growth resembles very much a simple papilloma. At times it is impossible to distinguish between the two tumours, and, as mentioned above, suspicion of the true nature of the growth first arises as the result of attempts to eradicate the tumour by diathermy.

Small cancers should be excised, even though this means taking away the lower end of the ureter; the upper cut extremity of this tube can be implanted into another part of the bladder. When the growth is very large the whole bladder may need removal. This means transplantation of the ureters into the sigmoid, or on to the surface of the body. It is a very severe operation and it is doubtful if it should ever be done, as it does not prolong the life of the patient for any considerable time. It is better to control pain by narcotics. A suprapubic opening, though it is sometimes recommended as a palliative, gives very little relief indeed from the agonising bladder cramps; it brings with it the added discomforts of the urine streaming over the abdomen.

Bilharzia

This is a disease endemic in Egypt and other eastern countries. The ova of the parasite (*Schistosoma haematobium*), discharged into water, enter into a snail where they undergo development; mobile larvae are formed which find access to the human body either through the skin or through the urethra. In the body they are transformed into the adult worms, which are about $\frac{1}{2}$ inch in length. At first the male and female forms lie together in one of the veins of the portal system. Afterwards the female migrates into one of the small veins of the pelvic plexus, and so comes to be in the submucosa of the bladder or the rectum. Here she lays her eggs. It is these structures which set up inflammatory changes which lead to the formation of granulation tissue and ulcers in the bladder. The ulcers have everted edges with a necrotic basis. The granulations frequently form large tumour-like masses.

The entry of the larvae sets up an irritation of the skin, followed, in a week or two's time, by some general symptoms of toxaemia. The bladder symptoms are pain, haemorrhage, frequency and pyuria because infection is always added. Occasionally the disease reaches the urethra and causes a stricture which may be either in the anterior or posterior part. Stones often form with the eggs as a nucleus. An eosinophilia is present. Death of the patient is likely to occur from spread of the infection to the kidneys.

The diagnosis is made by finding the ova in the urine. The granulation masses in the bladder are apt to be taken for a malignant tumour. For the infection, washes and the ordinary treatment of

cystitis should be carried out. Tartar emetic is the drug used to kill the parasite. It is given in doses of ½ to 2 gr. in 1 per cent solution intravenously, every other day, keeping a good look-out for symptoms of poisoning: headache, vomiting or diarrhoea. Another successful preparation of antimony is lithium antiomoniothio-malate intramuscularly three times a week. The first dose should be 0·06 gm., and this is increased at each dose by 0·03 gm., until rheumatic pains occur. Then the dose is diminished. The usual total dose is 0·12–0·24 gm. (12-20 injections). A second course of injections after a rest of three weeks may be necessary.

Acquired Urinary Fistula

After an operation for stone in the kidney a fistula leading into the renal pelvis may persist. If it should, almost certainly there is another stone blocking the ureter which needs removal. The fistula will quickly heal after this is done.

Fistulae of the bladder may be external or internal. After suprapubic prostatectomy, a persistent fistula sometimes remains because the drainage tube tract has become epithelialised. The only thing to do is to dissect away the bladder from the abdominal wall and to sew up the hole in it. The bladder fistula is very easily cured.

An internal fistula may form between the bladder and the colon or the vagina. Vesico-colic fistulae result, as a rule, from rupture into the bladder of an abscess around a diverticulum; very seldom is it due to a carcinoma of the bladder growing through into the colon. With a vesico-colic fistula a patient passes the most foul urine, and also flatus, through his urethra. The communication can be seen with a cystoscope. When the fistula is inflammatory in origin, it is surprising how the area of bladder wall affected is confined to the immediate neighbourhood of the aperture, and how well in health patients may be in spite of the foul urine. Sometimes, on opening the abdomen, it is found possible to separate the two viscera and close the resulting holes in them. If this should be impossible, a colostomy is the best treatment. When a carcinoma of the bladder breaks through into the colon, the disease is so advanced that no real good can come from operating; the patient is best left alone.

A vesico-vaginal fistula follows a penetrating wound or more commonly comes from the sloughing of the bladder wall from prolonged pressure of the foetal head during a difficult labour. Such a fistula is repaired by operating from the vagina, carefully separating the two structures, and sewing up the two holes in them.

A uretero-vaginal fistula is caused by an injury to the ureter

cases where the growth resembles very much a simple papilloma. At times it is impossible to distinguish between the two tumours, and, as mentioned above, suspicion of the true nature of the growth first arises as the result of attempts to eradicate the tumour by diathermy.

Small cancers should be excised, even though this means taking away the lower end of the ureter; the upper cut extremity of this tube can be implanted into another part of the bladder. When the growth is very large the whole bladder may need removal. This means transplantation of the ureters into the sigmoid, or on to the surface of the body. It is a very severe operation and it is doubtful if it should ever be done, as it does not prolong the life of the patient for any considerable time. It is better to control pain by narcotics. A suprapubic opening, though it is sometimes recommended as a palliative, gives very little relief indeed from the agonising bladder cramps; it brings with it the added discomforts of the urine streaming over the abdomen.

Bilharzia

This is a disease endemic in Egypt and other eastern countries. The ova of the parasite (*Schistosoma haematobium*), discharged into water, enter into a snail where they undergo development; mobile larvae are formed which find access to the human body either through the skin or through the urethra. In the body they are transformed into the adult worms, which are about ½ inch in length. At first the male and female forms lie together in one of the veins of the portal system. Afterwards the female migrates into one of the small veins of the pelvic plexus, and so comes to be in the submucosa of the bladder or the rectum. Here she lays her eggs. It is these structures which set up inflammatory changes which lead to the formation of granulation tissue and ulcers in the bladder. The ulcers have everted edges with a necrotic basis. The granulations frequently form large tumour-like masses.

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CHAPTER XLIX

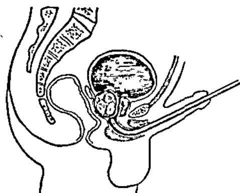
DISEASES OF THE PROSTATE AND SEMINAL VESICLES

Hypertrophy of the Prostate

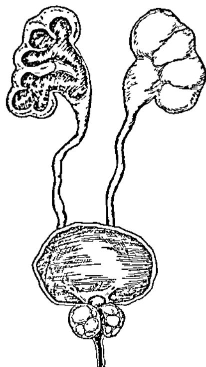
This name is given to obstructive enlargement of the prostate which comes on after 50 years of age, and generally does not cause pronounced symptoms until over 60: it is a nodular increase of glandular tissue which is embedded in a fibro-muscular stroma. The prostate becomes of great size. The adenomatous masses are usually arranged in three main groups: one on either side of the urethra, and one in the middle line. They are called the lateral and the middle lobes. All this enlargement is situated between the verumontanum and the neck of the bladder. The nature of the hypertrophy is not quite clear; although it is commonly called an adenoma, many pathologists regard the disease as a change due to some endocrine disturbance. There is some evidence for this because the injection of oestrone into monkeys does lead to enlargement of the prostate gland; more particularly to an increase of those glands which lie around the utriculus masculinus. Testosterone prevents this action. Long before oestrone had been discovered, it had been maintained that benign enlargement of the prostate in man is due to hypertrophy of the para-urethral glands lying partly under the mucous membrane at the neck of the bladder, and partly around the urethra between the bladder and the verumontanum; the enlargement of the former leading to a medial lobe, the increase of the latter to the lateral lobes. These glands first begin to proliferate and, pushing out into the surrounding tissue, become associated with smooth muscle fibres. They form small fibro-muscular nodules containing acini in the neighbourhood of the uterus masculinus and so have been thought to be analagous with fibromyomata of the uterus in the female. As the lateral lobes grow they push aside the true prostatic tissue, which becomes flattened out into what is called the false capsule. The new formation is easily separated from this layer which is left behind in enucleation of the

during hysterectomy; either the ureter is cut across without its being observed at the time, or a ligature is thrown round it, or it is deprived of its blood-supply so that it subsequently sloughs. Occasionally, by ureteric catheterisation, the fistula may be induced to heal; usually, however, it is necessary to operate. Successful results have been obtained by dissecting along the ureter from within the bladder, finding the proximal end and suturing it to the bladder wall. When the damage has been done at some distance from the bladder, this procedure becomes very difficult; it is then better to open the peritoneum and find the end of the ureter in the dense scar tissue always present on the side wall of the pelvis and to implant it into a new aperture made in the bladder.

meatus from behind. The interlacing bundles of muscle fibres in the bladder wall hypertrophy, giving rise to what is known as trabeculation; the bladder wall is thus much thickened; but as the obstruction increases, the tone of the muscle gives way and dilatation comes on. Sometimes the mucosa is pushed out between the hypertrophied bands of muscle tissue so that sacculation results. When the stretching has reached a certain point, the sphincters at the lower ends of the ureters become incompetent; then at each act of micturition the urine is forced up these tubes, which thus dilate and allow the back pressure to fall upon the kidney tissue. As the urinary secretory pressure is much less than that of micturition, the urine is forced up the renal tubules. A chronic interstitial nephritis is now set up, which depresses the function of the kidneys, and if the disease is allowed to proceed, will kill the patient from uraemia. Death will occur all the sooner if infection sets in, as it is very likely



The point of a catheter comes against the projecting prostate and will penetrate it, making a false passage unless it be kept in contact with the roof of the urethra by depressing the shaft between the thighs.

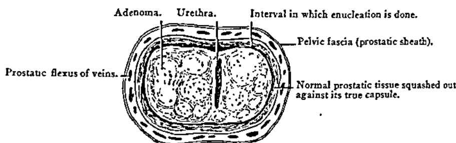


Hypertrophied prostate. Enlargement of median and lateral lobes (in section) causing dilatation of bladder, ureters and bilateral hydronephrosis.

to do owing to the stagnation of the urine. Men suffering from back pressure become anaemic, lose their power of response to infection, and frequently get myocardial degeneration.

Symptoms.—As a rule the first symptom is increased frequency of micturition, which is worse at night and disturbs the patient's sleep. On getting up in the morning, he may have to pass his urine several times at short intervals of a few minutes; and when the desire comes he must accede to it at once or his water will dribble away. The stream of urine loses all its force; it falls almost vertically from the

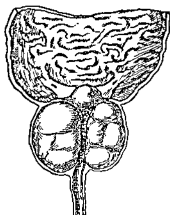
gland. As enlargement occurs in men over 50 years of age whose testicles are becoming less active; it is supposed that the lessened secretion of testosterone by the spermatogenic cells allows freer play of the oestrogenic substances also known to be produced by the testicle. Previous inflammation of the gland, gonorrhoeal or otherwise, does



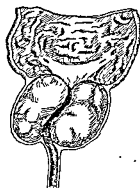
Cross-section of hypertrophied prostate.

not lead to enlargement of the prostate; but the vascular, diseased tissue is very prone to infection. Attacks of prostatitis and even abscess are complications of hypertrophy of the prostate.

As the growth proceeds the length of the prostatic urethra is increased; it is also usually deviated to one side, because the enlargement of the lateral lobes is never quite symmetrical. Another



Hypertrophied prostate: enlargement of both lateral and median lobes. The prostatic urethra is lengthened.

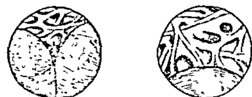


Hypertrophied prostate: unequal enlargement of the lateral lobes causes lateral curvature of the prostatic urethra.

important effect is the bulging forward of the posterior wall of the urethra, which happens because very little new formation takes place in front of the canal. It is against this projecting part of the gland that a catheter impinges unless very great care is taken to keep its point close to the anterior wall. Within the bladder the gland may rise up from the base like a dome, with the internal opening of the urethra at its summit; or the posterior part of the gland may project into the base of the bladder and overhang the internal urinary

kidneys are in danger of damage. Rather uncommonly bleeding occurs from an enlarged prostate; it may be so severe as to fill the bladder with clots and cause retention. If there is infection, a stone may form. Acute retention of urine can appear at any time; it may be the first symptom of an enlarged prostate in a perfectly healthy man. At other times a dilatation of the bladder goes on silently until it can proceed no further, at which stage the slightest extra movement or jar causes some urine to ooze out of the urethra. The patient complains of incontinence (overflow incontinence).

The diagnosis is suggested by the history. Nearly always the gland will be *felt to be enlarged from the rectum, but if there is* only a small middle lobe causing the trouble, it will not be detected in that way: a cystoscopy becomes necessary. With this instrument, trabeculation and sacculation of the bladder can be seen. If the cystoscope be withdrawn so that the lower edge of the internal meatus is visible, and a ureteric opening is in view at the same time, it is good evidence that the gland is enlarged. The normal internal meatus is concave all round, except the floor which is flattened or slightly convex. Enlarged lateral lobes bulge in at the sides, and when the beak of the cystoscope is pointed upwards there is a V-formation. Retention due to an enlarged prostate can scarcely ever be confused with that due to a stricture, because, in addition to the other features already mentioned, the obstruction to a catheter is felt to be in the bulb in stricture, but beyond the triangular ligament in an enlarged prostate.

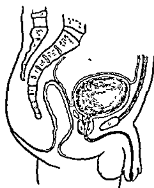


Enlarged prostate. Cystoscopic appearances when the prism is at the level of the internal sphincter. On the left the beak points upwards and the two lateral lobes are seen; on the right the beak points downwards and the middle lobe shows. In each case the trabeculated, sacculated bladder wall is seen at a deeper level.

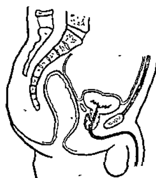
Treatment.—From what has been already said, it will be clear that an enlarged prostate, when it has reached a certain size, becomes a direct menace to life. When there is no infection this stage is reached when there are more than $3\frac{1}{2}$ oz. of residual urine (100 c.c.). This therefore is an indication for operation. The presence of sepsis is of the same import. Operation should also be considered when the patient's sleep is seriously interfered with by great frequency of micturition even though there is only a small volume of residual urine.

When there is no need for operative treatment, the patient should be enjoined to lead a quiet life. He should avoid exposure to cold, over-eating or drinking, or sexual excess. He should empty his bladder every two hours as a full bladder leads to congestion. He

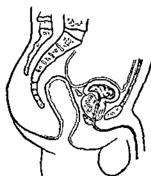
meatus; straining only makes the difficulty worse, the pressure within the bladder acting on the intravesical part of the gland, pushing it downward, thereby closing the beginning of the urethra. *A finger in the rectum feels the prostate to be larger than normal, smooth, elastic and rounded; the groove in the middle line separating the two lateral lobes is lost.* If a catheter is passed after the patient has voluntarily emptied his bladder, it will be found that there is still



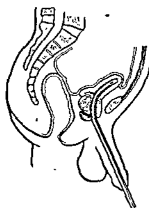
Normal full bladder. The peritoneal reflection rises in front with the bladder.



Normal bladder after micturition.



Bladder after micturition with enlarged prostate. Owing to stretching of its wall its cavity cannot be obliterated. Residual urine is left.



A catheter withdraws the residual urine because its extremity acts as a point of support to the bladder wall which is now able to contract closely around the instrument.

some urine within it; this is called residual urine and its amount is of much significance. The finding of residual urine really means that the bladder wall has been stretched so much that it can no longer contract down and obliterate its lumen. The tip of a catheter introduced into such a bladder will act as a point of support around which the viscus can contract and squeeze out the residual urine. The amount of this is thus a measure of the degree of stretching of the bladder wall which has taken place. Three to three and one-half ounces indicate that it has gone far enough to cause the sphincters at the lower ends of the ureters to become incompetent, and that the

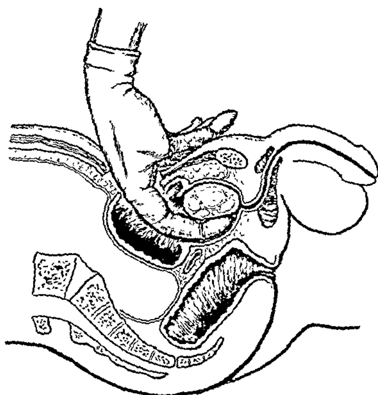
effective method is to compress the shell of the prostate against the back of the pubes with two fingers in the rectum, keeping the pressure up for ten minutes. At the same time pressure may be exerted from within the bladder over a pad which is pressed downwards. Sometimes a spurting vessel in the torn mucosa of the bladder will be seen and can be dealt with. In the Harris operation, deep sutures are passed through the prostatic tissues, drawing them tightly round a catheter in the urethra. With this method haemostasis may be so good that the bladder can be closed without drainage. It is questionable whether this is often desirable; the ragged walled cavity, left after enucleation of the prostate, always becomes septic, and the absence of free drainage may lengthen the time taken to overcome this. Moreover, the presence of sutures which are not absorbed, because of the sepsis, leads to a continuous irritation of the bladder which lasts much longer than when no sutures are used. Millin does not open the bladder, but having exposed the anterior aspect of the prostate behind the pubes, ties the dorsal vein of the penis and any tributaries, and opens the prostatic capsule in front. Through this wound he enucleates the prostate, introduces a catheter into the bladder and sutures the prostatic capsule closely around it, stopping all haemorrhage. The operation is under trial but it does not seem very desirable to interfere with the venous drainage from the penis. Hey opens the bladder and enucleates the prostate in the ordinary way. By removing a large wedge from the posterior aspect of the internal urinary meatus he is able to get such free access to the cavity left after enucleation that he is able to effect haemostasis by the diathermy cautery. He then closes the bladder, leaving in a catheter which has been passed from within the bladder outwards. He lays great stress upon this in order to avoid the introduction of organisms from the anterior urethra and also insists that no instrument should have been passed within about a week of the operation.

Perineal prostatectomy is carried out through a curved incision between the rectum and the bulb of the urethra. The bowel is pushed backward, the prostatic capsule opened above the compressor urethrae muscle, and the hypertrophied tissue removed. It is easier to obtain haemostasis by this route, and drainage of the prostatic cavity is better; but the operation is not done much in this country because of the fear of incontinence following, and the risk of injury to the rectum. The operation is technically difficult, but in skilled hands these risks are small.

Perurethral prostatectomy is effected either by punching a number of fragments from the gland by means of an instrument passed through the urethra, or by cutting pieces away with a diathermy loop. In both cases haemostasis is brought about by the coagulating current.

should be seen every few months to ascertain whether his residual urine has increased to the danger point.

When an operation has been decided upon, several examinations must be made. The blood urea should be below 50 mg. per 100 c.c. for a one-stage operation to be done without great risk, and the urea concentration test should be above 1·5 per cent. A haemoglobin estimation is important; it is very risky to operate if the result is less than 70 per cent, for the procedure is one associated with a loss of blood the amount of which cannot be foretold, and which is not



Suprapubic enucleation of the prostate with the finger.

under exact control. Some idea of the condition of the patient's heart can be got by observing how quickly his pulse returns to normal after some slight exercise, as walking up a short flight of stairs.

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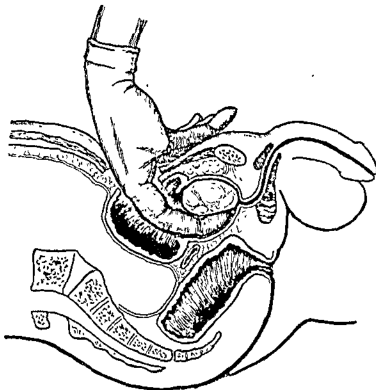
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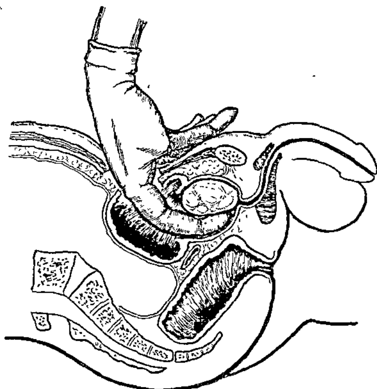
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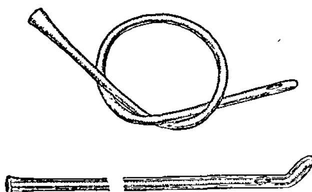
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through the large tube which drains the bladder.

The treatment of enlargement of the prostate by the administration of testosterone propionate is being given a trial.

Retention of Urine due to an Enlarged Prostate.—This is of two types. There is the acute retention which comes on in a vigorous man in the late fifties who has perhaps had no urinary symptoms at all until he finds himself unable to pass his water and suffers extreme pain; and there is the painless incontinent type in a decrepit old man, who really thinks that he has incontinence, because the high pressure in the bladder, distended to the umbilicus or above, forces urine past the sphincters on every little additional exertion. The diagnosis of retention due to an enlarged prostate from that due to fibrous stricture of the urethra has been described above (page 717).

In the acute type associated with pain it is usually quite safe to empty the bladder by a catheter. For this purpose a rubber catheter

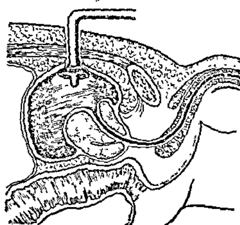


A soft rubber catheter and a gum-elastic coudé catheter.

should be tried first, and if this fails to pass an elbowed (coudé) catheter of good size (16-18 F.). Only rarely is a silver catheter necessary. Once relieved there may be no further symptoms for a considerable time, though another attack of retention is likely.

Emptying the bladder quickly in the painless type is, however, fraught with the risk of uraemia and death. This is due to the elastic recoil of the kidney structure on the release of pressure, which kinks the collecting tubules and leads to suppression of urine. Indeed the flow of urine can be re-established by filling the bladder again with sterile saline solution. The urinary tract, therefore, must be decompressed gradually; and this is done by an in-dwelling catheter furnished with a stopper which is removed every 2 hours to draw off 8 oz. of urine until the bladder is emptied. After this the catheter should be attached to a tube whose end dips under some antiseptic lotion. Continuous drainage is carried out for a week, at the end of

In this country the method is reserved for obstruction due to carcinoma or bar formation; but in some clinics in America nearly all prostates are removed by this route. The patient leaves the hospital in less than a week but the operation requires much skill and experience; sepsis and bleeding after the operation may cause considerable trouble, and indeed lead to death.



Self-retaining catheter in suprapubic opening when the bladder needs preliminary draining for a long period.

If the results of the examination of the blood and the urine of a prostatic are not sufficiently good, a two-stage operation should be performed. As a first step, a suprapubic opening is made into the bladder, and the patient fitted with an apparatus to collect the urine, so that he can be up and going about. Usually in two or three weeks' time, but sometimes only after many months, the blood urea and the concentration tests show that the kidneys have recovered sufficiently for it to be possible to remove the gland without a great risk. The second operation is usually done through the opening already present in the bladder. This two-stage operation procedure is so safe that some surgeons do it as a routine; but Hey claims that a two-stage operation is never necessary and that if infection is guarded against by carrying out his procedure there is no added risk in a one-stage operation, even in cases of retention with overflow.

Prostatectomy, however done, must be regarded as a serious operation. Death may take place after it from uraemia, haemorrhage, septic pyelonephritis, septic lung complications or pulmonary embolism. The results in those patients that recover are very good though it may take some time before the urine becomes aseptic, so that some frequency may persist for a considerable period.

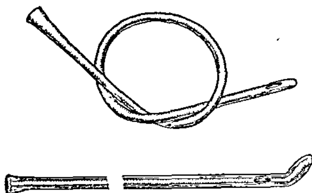
Treatment with calcium mandelate or with sulphonamide may be needed. It must be remembered that, after enucleation, a cavity with ragged torn walls is left. Devitalised tags must slough off before epithelialisation from above and below can take place. This ragged surface becomes covered over with granulation tissue in four or five days, after which it is less vulnerable to infection. Infection can be kept under control during the first five days by continuous irrigation of the cavity with saturated sulphanilamide in normal saline solution through a narrow tube sewn into the cavity with a removable stitch, the ends of which, with the narrow tube, emerge

through the large tube which drains the bladder.

The treatment of enlargement of the prostate by the administration of testosterone propionate is being given a trial.

Retention of Urine due to an Enlarged Prostate.—This is of two types. There is the acute retention which comes on in a vigorous man in the late fifties who has perhaps had no urinary symptoms at all until he finds himself unable to pass his water and suffers extreme pain; and there is the painless incontinent type in a decrepit old man, who really thinks that he has incontinence, because the high pressure in the bladder, distended to the umbilicus or above, forces urine past the sphincters on every little additional exertion. The diagnosis of retention due to an enlarged prostate from that due to fibrous stricture of the urethra has been described above (page 717).

In the acute type associated with pain it is usually quite safe to empty the bladder by a catheter. For this purpose a rubber catheter



A soft rubber catheter and a gum-elastic coudé catheter.

should be tried first, and if this fails to pass an elbowed (coudé) catheter of good size (16-18 F.). Only rarely is a silver catheter necessary. Once relieved there may be no further symptoms for a considerable time, though another attack of retention is likely.

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which time the tests for renal efficiency are carried out. It is no use doing them before this time. All these patients need a prostatectomy.

Median Bar Obstruction

There are patients who suffer from symptoms of enlargement of the prostate in whom the prostate is not increased in size. There is an obstruction at the neck of the bladder in the form of a transverse bar situated behind the urethra. This bar is sometimes formed by the hypertrophy of the subcervical glands; at others it is a fibrous structure, and projects forwards as a narrow shelf overhanging the verumontanum. This form of obstruction is recognised by the absence of any enlargement of the prostate on rectal examination, and of a projecting middle lobe on cystoscopy. There are the frequency, residual urine and other signs of prostatism. The ridge can be seen with the cysto-urethroscope, projecting over, and close to the verumontanum.

In this condition very good results have been obtained with the punch. An alternative and very good method is to open the bladder and to remove a wedge from the posterior margin of the internal meatus with the knife.

Prostatic Calculi

Stones found in the prostate are primary and secondary. Secondary stones are those which have come from the bladder and become lodged in the prostatic urethra; they are, of course, of the same composition as vesical stones. Primary calculi are not very common. They are usually multiple, small in size, and often form round corpora amylacea. They are never found in the adenomata of hypertrophy, but frequently are discovered in numbers at the operation, embedded in the original prostatic tissue surrounding the adenoma.

There are no symptoms unless the stones reach the urethral lumen. Then frequency and pain appear. Incontinence of urine or retention sometimes happens. Ejaculation is painful. A large single stone may sometimes be felt on rectal examination, resembling very much the hard nodule of a carcinoma; and very rarely small multiple calculi may be made to grate together. If infection is added, there is constant pain in the bladder, rectum and perineum, and all the signs of prostatitis and cystitis. An abscess may be the result.

In the absence of symptoms no treatment is necessary, but if the patient suffers, the stones should be removed through a perineal incision as for removal of the prostate.

Acute Prostatitis

The prostate becomes infected either from the urethra or through the blood-stream. Ninety per cent of all cases are due to gonorrhoea; but even then the infective organism may be the staphylococcus, the streptococcus or the *Bacillus coli.* Cystitis, or catheterisation, or instillations into the posterior urethra, may cause prostatitis by the urethral route. Blood-stream infection takes place in such diseases as pneumonia, furuncles, pharyngitis, the organism being the same as that of the primary disease. This primary lesion may be so slight that it is actually overlooked. The intense infection is often confined to one part of the gland; and perhaps in that part an abscess will form. Such an abscess may rupture into the urethra, into the rectum, or much more rarely on the perineum.

The symptoms are pain in the perineum and rectum, frequency, strangury and terminal haematuria. The swelling of the gland may give rise to retention. On rectal palpation the prostate is much swollen and very tender; light pressure with the finger will cause secretion containing pus and epithelial cells to ooze out of the meatus. The urine is clear for the first few days of the prostatic infection, but it then contains pus. Digital examination should be carried out very gently, because the disease may be disseminated by the procedure, and even become generalised by being forced into the prostatic venous plexus.

The treatment aims first at relieving the pain by morphine and hot sitz baths. When there is posterior urethritis, instillations of 2-3 per cent protargol should be given. Retention will need the passage of a rubber catheter. Penicillin or sulphonamides should be administered. When a softening is felt in one part of the prostate on rectal examination, denoting that pus is collecting, an incision must be made into it by the perineal route. Many prostatic abscesses open spontaneously into the urethra, and cure results; but this should not be waited for. It is a serious complication if the rupture takes place into the rectum, giving rise to a recto-urethral fistula.

Chronic Prostatitis

Chronic prostatitis often results from an acute attack, but it also comes on without any acute stage, especially in gonorrhoea.

There are a fulness, or perhaps some pain, felt in the perineum or rectum; frequency of micturition, and attacks of sudden, very imperative desire to empty the bladder; a less forcible stream; short-lived bouts of retention; sex disturbances such as ejaculatio praecox,

and impotence; and neurasthenia or hypochondriasis. The gland may not feel enlarged to the finger in the rectum; by this route it is usually found to be of irregular consistency and not tender. If its secretion be expressed, it will be seen to be watery, or yellowish in colour, and contains pus, blood, corpuscles and epithelial cells, but no lecithin crystals. There are comma threads in the urine. The disease is very chronic and may last for years; at any time it may cause cystitis or pyelitis; or it may be a focus of infection causing metastatic joints.

The treatment of this disease is troublesome. Not only is it very difficult to cure, but the patients are very likely to become neurasthenic. Massage should be done twice weekly from the rectum, after the instillation of 2 per cent protargol into the prostatic urethra. Care is necessary, for if there are joint symptoms, massage may cause their exacerbation. It should never be persisted in longer than 6 weeks. The general health should be looked after. Penicillin or sulphonamide cures many cases. If there is an evacuated abscess cavity which is not draining properly, it is sometimes right to expose the prostate from the perineum, and to curette it.

Tuberculosis of the Prostate

Tuberculosis of the prostate is often primary and without symptoms. *When the patient is aware of it, the symptoms are the same* as those of chronic prostatitis, but there are no nervous disturbances. The appearance of blood, at the end of micturition, is characteristic. The bacillus is not always found in the urine.

The treatment is the care of the patient's general health, and the injection of tuberculin; massage is contra-indicated. Spread of the disease is likely to take place to the epididymis.

Spermatocystitis

Spermatocystitis, or inflammation of the seminal vesicles, has a similar origin to prostatitis; indeed all that has been said in this respect about prostatitis might equally well be said of inflammation of the seminal vesicles.

The symptoms of acute spermatocystitis are pain deep in the perineum and in the posterior urethra, especially felt at the end of micturition. The pain is made worse by defaecation, and often radiates to the back and testicle. The upper part of the inflamed seminal vesicle, lying against the lower end of the ureter, may obstruct it and cause renal colic. Urinary symptoms are usually present

because the disease is accompanied by prostatitis or cystitis. The urine consequently contains pus and shreds. Rectal palpation reveals the very tender swollen vesicles just above the base of the prostate. The treatment of the condition is on the same lines as that for acute prostatitis. Very rarely an abscess forms and ruptures into the bladder or into the rectum. Extremely rarely is it necessary to evacuate the pus by the same route as a prostatic abscess is opened. Now and then the inflammation spreads to the prostatic plexus and causes a pyaemia.

In chronic vesiculitis, dull pain is felt in the testicle, perineum and sacral region. Frequency of micturition, with some pus or threads in the urine, is common. Erections and pollutions denote increased sexual excitability. Sometimes there is blood in the semen. A polyarthritis may occur. Rectally the seminal vesicles are felt to be indurated. Posterior urethroscopy reveals an inflammation around the colliculus and perhaps purulent fluid coming from the ejaculatory ducts. Patients with chronic vesiculitis are apt to become neurasthenic.

In the treatment of the chronic condition it is very necessary to improve the general health of the patient, and, if possible, to get him to engage in some outdoor occupation or sport. Massage of the prostate may be done twice a week as in the treatment of chronic prostatitis; before doing it, boric lotion should be put into the bladder, and an instillation of 2 per cent protargol into the posterior urethra, to prevent these structures being infected with the expressed fluid. Penicillin or sulphonamide may bring about a cure in a short time. Very rarely does it become necessary to curette or excise the vesicles through a perineal incision. Sometimes protargol is injected into the vesicles by exposing the vasa deferentia at the root of the scrotum and inserting a small cannula, but the effect is not very striking so the procedure has not gained general acceptance.

Carcinoma of the Prostate

This is an adenocarcinoma of the simple type. It is said to occur in 15 per cent of all cases of benign enlargement, but whether the one disposes to the other, or whether the two diseases coexist because they both occur at the same period of life, is not clear. A carcinoma of the prostate tends to grow upwards into the seminal vesicles and so to the base of the bladder; it spreads by the lymph vessels into the glands in the pelvis, and sometimes, curiously enough, to the inguinal glands; cells also permeate along the nerve sheaths, giving rise to unbearable pain. Metastases are common in bones, particularly in

and impotence; and neurasthenia or hypochondriasis. *The gland* may not feel enlarged to the finger in the rectum; by this route it is usually found to be of irregular consistency and not tender. If its secretion be expressed, it will be seen to be watery, or yellowish in colour, and contains pus, blood, corpuscles and epithelial cells, but no lecithin crystals. There are comma *threads in the urine.* The disease is very chronic and may last for years; at any time it may cause cystitis or pyelitis; or it may be a focus of infection causing metastatic joints.

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case the seminal vesicles must be taken away with the growth. Though recurrence may take place in perhaps a year, the patient will have been saved much pain.

Good reports have been published of the effect of stilboestrol in carcinoma of the prostate. The symptoms appear to be relieved and the gland to shrink and become softer, though cure is not claimed. Stilboestrol reduces the excess of phosphatase in the blood; 1 mg. is given t.d.s. and the dose increased to 2-3 mg. until the serum phosphatase becomes normal. Then 1 mg. a day may be sufficient to control symptoms. Even without serum phosphatase estimations it seems quite safe to give stilboestrol.

Sarcoma of the Prostate

Sarcoma of the prostate is very rare. It occurs in young people, even in children. It forms a large smooth mass in the prostate which grows with incredible rapidity. Metastases are not met with. It causes urinary symptoms as a carcinoma. Radical treatment is never possible.

the lumbar spine and the bones of the pelvis; they also appear in the lungs, and are sometimes seen in the supraclavicular glands. How the cancer cells reach the bones has been described on page 510.

Carcinoma of the prostate is very often a silent disease; metastases may be the first intimation of its presence. At other times the patient complains of the same symptoms as those of benign enlargement. When a rectal examination is made, a very hard nodule is felt in the prostate; or if the disease is advanced, the whole gland may be one indurated mass. Retention occurs as in benign enlargement, and also bleeding. Pain, because of the invasion of the sacral nerves, may be a very prominent feature. It is felt in the legs, and is very severe and intractable. Whenever a man in middle life complains of sciatica, his prostate should be examined. Enlarged glands may be found in the iliac fossa or in the groins. Cystoscopy will show whether the growth has invaded the bladder or not.

The amount of phosphatase in the blood is of some diagnostic importance. The normal prostate reacts to the injection of androgen by pouring phosphatase into the blood. In health there is very little phosphatase in the blood; perhaps none. In established carcinoma of the prostate and especially when there are metastases in the blood acid phosphatase appears in the serum. Five or more units per 100 c.c. are pathognomonic of carcinoma of the prostate.

The growth of a carcinoma of the prostate is often slow. The patient may live 4 or 5 years after the diagnosis has been made. He dies from cachexia, or pyelonephritis, or from uraemia. In the later stages the pain is very great if the sacral plexus becomes involved; and to this may be added the almost intolerable agony of frequent bladder cramps, excited by the invasion of the wall of this viscus by the growth.

Carcinomata of the prostate are not often removed because they are usually met with too late for this to be practicable. In such cases no more can be done than to relieve the pain by sedatives, and the retention by a catheter. Suprapubic cystotomy does nothing to lessen the bladder cramps. Indeed it only adds to the misery of the patient; it should never be done. Cases of retention may be relieved by the perurethral punch or diathermy operation.

Because of the few cases of long cure after removal of the prostate for carcinoma, it is seldom done; but it should be considered whenever it appears to be practicable. Usually the operation is performed from the perineum, but equally good, and quicker, results are obtained by operating from above, a route which has the advantage of allowing the surgeon to see whether the growth has actually invaded the bladder wall before he begins the removal of the prostate. In any

it occurs more often when the infection is due to a pyogenic organism. Quite often after a short interval the epididymis on the opposite side becomes affected.

The diagnosis is easy. In urethrogenous infections there are always pus and threads in the urine in which the gonococcus or other organism is found. In metastatic infections the urine is quite clear. An infection spreading along the vas may cause a local inflammation of the overlying peritoneum; abdominal pain and vomiting result. If this occurs on the right side, appendicitis may be simulated.

The patient should go to bed and the scrotum should be supported on a cushion. Moist fomentations form the best application. The underlying condition should receive the appropriate treatment but local urethral medication and instrumentation should be given up for a time. An abscess may need opening. Penicillin or sulphonamide is usually called for.

Acute Orchitis

This may be simply an extension from an acute epididymitis or a blood-stream infection in such conditions as mumps, smallpox, typhoid fever, influenza, pneumonia, malaria or sepsis. Why in some cases the infection settles down in the testis whilst in others it attacks the epididymis is not known. In mumps the organism affects the testis only in adults. It is often a bilateral infection, and, as the testis may subsequently atrophy, the patient stands a considerable risk of becoming sterile. Gangrene of the testis may actually occur from the pressure of inflammatory exudate within the inextensible tunica albuginea.

The clinical symptoms resemble very much those of epididymitis, but as the swelling begins in the body of the testicle there is not the characteristic crescentic swelling. The vas deferens of course is not thickened, but the other structures of the cord may be infiltrated with inflammatory exudate.

The treatment is carried out on the same lines as in acute epididymitis. Sometimes an incision through the tunica albuginea is needed to lower the pressure and avert the onset of gangrene.

Chronic Inflammations of the Testicle

Chronic inflammations of the testicle result from infections with the *Bacillus tuberculosis*, very much less frequently with the *Treponema pallidum*, rarely with ordinary pyogenic organisms.

CHAPTER L

DISEASES OF THE TESTICLE

ACUTE INFLAMMATIONS OF THE TESTICLE

Acute Epididymitis

ACCORDING to their origin two forms are described: (1) Urethrogenous epididymitis in which the infection spreads from the urethra either by the lumen and by the agency of antiperistaltic waves in the vas, or by the perivasal lymphatics. (2) Metastatic epididymitis in which the infection takes place by the blood-stream, the cells lining the epididymal tube removing the microbes from the blood and excreting them into the lumen. In this connection it is interesting to remember that the epididymis is developed from the Wolffian body, the primitive excretory organ of the embryo.

The urethral infection is usually a gonococcal one, but epididymitis may be due to staphylococci, streptococci or the *Bacillus coli* when it is secondary to prostatitis, vesiculitis or cystitis. Antiperistaltic waves in the vas deferens are set up by such stimuli as injury to the testis, the passage of a catheter, or the irritation of the verumontanum by an instillation in the prostatic urethra. Metastatic infection may take place in typhoid fever, or from a furuncle or sore throat, there being no infection of the urinary tract.

In acute epididymitis there are acute pain in the testicle and a raised temperature; the epididymis swells up to form a crescentic tender mass embracing the body of the testis behind, unless there is inversion of the testicle when it lies in front. The skin of the scrotum is oedematous and red. Soon the groove between the epididymis and the testis becomes obliterated and the two structures fused into one mass. The cord above the testicle is infiltrated and the vas thick. In urethral infections the prostate and seminal vesicles are usually swollen and tender.

The acute symptoms last only a few days, after which the inflammation gradually subsides. Abscess is very rare in gonorrhoeal infections;

it occurs more often when the infection is due to a pyogenic organism. *Quite often after a short interval the epididymis on the opposite* side becomes affected.

The diagnosis is easy. In urethrogenous infections there are always pus and threads in the urine in which the gonococcus or other organism is found. In metastatic infections the urine is quite clear. An infection spreading along the vas may cause a local inflammation of the overlying peritoneum; abdominal pain and vomiting result. If this occurs on the right side, appendicitis may be simulated.

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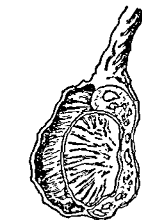
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Tuberculous Epididymitis

In the majority of cases the tubercle bacillus attacks the epididymis primarily, the infection taking place through the blood-stream. It is an excretory infection, the first changes being observed in the *epithelium*; only later does a reaction appear in the interstitial tissue. Sometimes, however, the invasion of the epididymis would seem to take place through the lumen of the vas deferens or by the perivasal lymphatics, travelling by these paths from a focus in the prostate or seminal vesicle, which structures have been themselves infected from a primary haematogenous infection of the opposite epididymis. Tuberculosis of the kidney spreading to the bladder and thence onwards accounts for a considerable number of cases.

The disease usually begins in a painless insidious manner so that for a long time it is not observed by the patient. Very often he finds accidentally a lump in his scrotum. Much less commonly there is an acute onset which resembles a gonorrhoeal attack of epididymitis; but of course there are no gonococci to be found in the urine, though occasionally there is a slight urethral discharge from a tuberculous lesion in the prostate, or pus in the urine if there is a tuberculous cystitis. In the ordinary case the urine is quite clear as the epididymitis is the first lesion in the genito-urinary tract. The globus minor becomes thickened but the change spreads to the rest of the epididymis, which is transferred into a hard crescent with an irregular surface embracing the posterior aspect of the testis. It is not tender to the touch except on hard pressure. The body of the testis is at first normal to feel, with ordinary testicular sensation retained. Later, the pathological process spreads to the body of the testicle which becomes fused into one mass with the epididymis, from which it becomes indistinguishable. There may be a small hydrocele. The tuberculous focus in the epididymis may caseate, soften, become adherent to the skin which at last breaks down, leading to the formation of a tuberculous sinus at the back of the scrotum. Very often there are small bead-like nodules in the vas above the testicle, very different from the larger single nodules of growth sometimes seen in malignant disease. Rectal palpation frequently reveals the presence of a hard nodule of tuberculous tissue in the prostate or an induration of the seminal vesicle.



Tuberculosis of epididymis. *Numerous caseating* areas in the enlarged epididymis. Small hydrocele.

In those cases where the disease is a part of a general infection of the urinary tract there are frequency of micturition and pus with tubercle bacilli in the urine.

Unless there are these last two signs there is no need to perform a cystoscopy.

The disease is a serious one, for although it is often the primary lesion in the genito-urinary tract it is always secondary to a focus somewhere else in the body, such as a lymphatic gland in the chest or abdomen. If there is no evidence of disease elsewhere in the urinary tract, it is best to put the patient under the best hygienic conditions and give him injections of tuberculin. Many cases get well under this treatment, but should the disease, from the early lesion in the globus minor, progress to the rest of the epididymis, an operation should be performed. Epididymectomy should be done whenever possible. If the patient has been allowed to wait too long and the disease to invade the testis itself, there is nothing possible but an orchidectomy. Since the disease becomes bilateral in about one-half of the cases, some surgeons recommend that the vas deferens should be tied on the healthy side whenever one testicle is operated upon. The wisdom of this advice is questionable in view of the certain sterilisation it brings about and the fact that the disease is often curable with the preservation of fecundity.

When the disease is part of a more general urinary tract infection, if only one kidney is affected, the epididymis should first be removed and then shortly afterwards the offending kidney.

Chronic Pyogenic Epididymitis

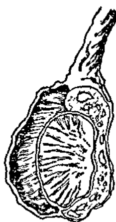
This is due to infection with staphylococci or the *Bacillus coli*, very seldom with streptococci. It may be a metastatic infection from such a focus as a sore throat or an enteritis; or an extension from the prostatic urethra, particularly in association with the urethritis which occurs with an enlarged prostate. The clinical features are very similar to those of tuberculous epididymitis but the infection never spreads to the body of the testis. The crescentic swelling is somewhat tender to the touch and not so craggy. The seminal vesicles may feel large on rectal examination. There is always pus in the urine or threads denoting posterior urethritis or chronic prostatitis. On microscopic examination the causal organism is found. Sometimes a gonorrhoeal epididymitis passes after the acute stage into a chronic condition and rarely it is chronic from the first.

Treatment consists in the correction of the primary condition and the local application of iodine or ichthyol ointment. Penicillin

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The disease usually begins in a painless insidious manner so that for a long time it is not observed by the patient. Very often he finds accidentally a lump in his scrotum. Much less commonly there is an acute onset which resembles a gonorrhoeal attack of epididymitis; but of course there are no gonococci to be found in the urine, though occasionally there is a slight urethral discharge from a tuberculous lesion in the prostate, or pus in the urine if there is a tuberculous cystitis. In the ordinary case the urine is quite clear as the epididymitis is the first lesion in the genito-urinary tract. The globus minor becomes thickened but the change spreads to the rest of the epididymis, which is transferred into a hard crescent with an irregular surface embracing the posterior aspect of the testis. It is not tender to the touch except on hard pressure. The body of the testis is at first normal to feel, with ordinary testicular sensation retained. Later, the pathological process spreads to the body of the testicle which becomes fused into one mass with the epididymis, from which it becomes indistinguishable. There may be a small hydrocele. The tuberculous focus in the epididymis may caseate, soften, become adherent to the skin which at last breaks down, leading to the formation of a tuberculous sinus at the back of the scrotum. Very often there are small bead-like nodules in the vas above the testicle, very different from the larger single nodules of growth sometimes seen in malignant disease. Rectal palpation frequently reveals the presence of a hard nodule of tuberculous tissue in the prostate or an induration of the seminal vesicle.



Tuberculosis of epididymis. Numerous caseating areas in the enlarged epididymis. Small hydrocele.

(2) Infantile hydrocele. This is very similar to a congenital hydrocele except that the pin-point aperture which connects with the peritoneum is closed; the swelling also extends up along the inguinal canal but it is no longer reducible into the peritoneal cavity.

(3) Encysted hydrocele of the cord. The liquid is in an unobliterated part of the funicular process which is shut off from the tunica vaginalis below and the peritoneum above.

(4) Hydrocele of the canal of Nuk. Of course seen only in females and comparable with the encysted hydrocele of the cord in the male.

(5) Hydrocele of the tunica vaginalis. The liquid collects in a normally formed tunica vaginalis.

(6) Hydrocele of the testis or the epididymis. Cysts in the epididymis or testis.

(7) Hydrocele in a hernial sac which has lost its connection with the general peritoneal cavity.

Congenital Hydrocele is seen in infants and the collection of liquid is said to be due to some intestinal upset which causes an inflammation of the gut wall and the pouring-out of serous liquid. The tunica being the lowest part of the peritoneal cavity when the child is upright, the liquid naturally collects there. As the communication with the peritoneal cavity is very small, it is not always possible clinically to make the swelling disappear by pressure; but the mother will give the information that it does go away during the night.

Usually no treatment is necessary in such cases, as the aperture seals itself off as the child grows and there is no further trouble.

Infantile Hydrocele.—The diagnosis is easily made by the fluid feel of the scrotal swelling, the translucency, and the fact that, although the swelling reaches up the inguinal canal as a congenital hydrocele does, there is no history of its disappearing during the night. If the liquid be evacuated through a small-bore needle there will usually be no more trouble. It is never necessary to operate upon these infants; and, of course, no irritant injection should ever be put into the tunica vaginalis of a baby or damage might be done to the delicate testis.

Encysted Hydrocele of the Cord.—This is usually seen in young adults. It is a rounded translucent swelling lying within the spermatic cord; it can be fixed by pulling on the testicle, thereby putting the cord on the stretch. It should be removed by open operation.

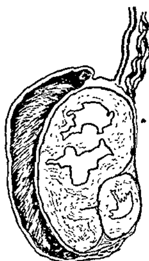
A hydrocele of the canal of Nuk has very similar characters and should be removed in the same way.

Hydrocele of the Tunica Vaginalis is said to be primary when the liquid collects in the sac for some, at present, unknown reason: secondary, when the fluid exudes as the result of some recognisable

should be given in staphylococcal infections, sulphonamide when the disease is due to the *Bacillus coli*.

Syphilis of the Testicle

Syphilis attacks the testicle in the tertiary stage of the disease. Nearly always it is the body of the testis which is affected; very rarely the epididymis, in which case, unlike the tuberculosis, the nodule is likely to be in the globus major. As a rule the body of the testicle becomes painlessly enlarged and loses its peculiar testicular sensation. There may be a small hydrocele. If there is a general gummatous infiltration of the organ, the enlargement of the testis is uniform and the surface smooth with some small nodules on the surface should the process have spread to the tunica albuginea; when there is a single gumma there is a localised nodule which projects somewhere from the surface of the testis. It is not usually possible to feel the epididymis separately from the testicular body. A gumma may enlarge, caseate, soften, reach the surface and break through with the formation of a syphilitic ulcer which is on the front of the scrotum, in distinction to a tuberculous sinus which is behind.



Tertiary syphilis of testis. Caseous areas in body of testis. Hydrocele present.

If the disease takes its natural course and goes on to spontaneous cure there is always atrophy of the testicle; this result occurs also when treatment is begun late.

Antisyphilitic treatment assures a speedy cure. Locally ung. hydrarg. ox. flav. is a good application. If there is extensive destruction of the testicle with herniation of the testis through the scrotum, as sometimes happens (fungus testis), it is wise to remove the testis as the organ will never function again either as an external or internal secreting gland.

Hydrocele

A hydrocele is a collection of liquid in a sac situated within the scrotum or the inguinal canal.

Several varieties are recognised:

(1) Congenital hydrocele. The tunica vaginalis is not quite shut off from the peritoneal cavity, so that fluid collecting in it forms a swelling which surrounds the testis and extends up along the inguinal canal as far as the internal ring.

The secreting surface of the tunica can sometimes be destroyed by injecting 5-10 c.c. of glyc. acid. carbol. into its cavity. Granulations form all over it, and the sac is obliterated. This method is not always successful, and, as it is associated with a good deal of inconvenience, and perhaps some pain, it is not often employed. Phenol is better than iodine or sodium morrhuate because it has local anaesthetic properties.

It may be advisable to tap a secondary hydrocele but the treatment of this condition is really the treatment of the primary disease.

Hydrocele of the Testis or the Epididymis.—This is also called a spermatocele; it is due to fluid secreted into a testicular tubule which has not made its connection with the rete testis or into a vas aberrans of the epididymis. The condition is seen in adults. In both cases there is a spherical swelling lying on the top of the testicle which is painless, of slow growth and translucent. The liquid within is clear and opalescent, of a low specific gravity, 1·002–1·005, quite free from albumen, and, if the cyst arises from a testicular tubule, is likely to contain spermatozoa. The swelling may become so large that it resembles a hydrocele of the tunica vaginalis; but whereas the sac of such a hydrocele envelops the testis concealing it, the swelling of a hydrocele of the testis or epididymis forms a lump separate from the testis; on palpation both structures can be easily distinguished.

These cysts are easily removed by open operation.

Hydrocele of a Hernial Sac.—Sometimes, owing to inflammation from a partial incarceration, a piece of omentum, or more rarely a loop of intestine, may obliterate the upper aperture of a hernial sac. If liquid collects, a hydrocele results. The characters of such a swelling are like those of an infantile hydrocele, but the condition occurs in adults and there is always the history of there having been a hernia. An open operation should be performed for its cure. The injection of irritant liquids is dangerous.

Haematocele

A haematocele is a collection of blood in the tunica vaginalis. It may result from a blow on the testicle, from the unskilful tapping of a hydrocele, so that the testicle is punctured, or be associated with a malignant growth of this organ.

It forms a swelling in the scrotum which is very similar to that of a hydrocele, but there is no translucency. In large haematoceles the blood, as it collects, gradually separates the testis from the epididymis by distending the cavum vaginale, until finally the epididymis becomes embedded in its wall. The wall itself becomes very thick, fibrous

inflammation in the testicle, as happens in tuberculosis, syphilis or sometimes pyogenic inflammations.

Primary hydrocele, also called idiopathic, is met with usually in middle-aged men but sometimes in quite young persons. It is a painless swelling in the scrotum which is somewhat pear-shaped in form, fluctuates, and is translucent. In making the last test the position of the testis, which may otherwise be concealed by the swelling, will be revealed. It is generally behind, but sometimes in front. The cord can be felt unaltered above the upper rounded extremity of the hydrocele. The accumulation of the liquid is slow, taking weeks or many months, and there seems almost no limit to the size of the swelling if nature is allowed to take her course. However, when it has become so big that the penis is becoming buried, the most imperturbable patient usually seeks relief. The condition is often bilateral. There is no complaint except of the bulk, and a dragging pain if the tumour is very large. If the condition has been in existence for a long time, the wall of the sac may have become very thick; occasionally calcification occurs in it.

The contents of the sac are an amber liquid which has a specific gravity of 1·015–1·025, contains a large quantity of albumen, namely 6 per cent, and coagulates on boiling; it also contains fibrinogen but no fibrin ferment, so that it does not clot spontaneously; it can be made to do so if the deficiency is made good by adding a drop or two of blood. If a haemorrhage has taken place into the sac or the wall is very thick, its translucency is lost.

The first step in treatment should always be an evacuation of the liquid through a small cannula, the position of the testicle having been determined by palpation and transillumination in order to avoid damage to it. Puncture of the testis is not only painful but will give rise to a haematocele which is certain to require operative treatment, whereas sometimes a simple puncture of the sac will lead to the permanent disappearance of the liquid. Usually there is reaccumulation, but this may be so very slow that the patient may elect to undergo the small inconvenience of periodic tappings; in the end he nearly always wants an operation. This consists in exposing the sac and cutting away the whole of the parietal layer of the tunica vaginalis. The testicle is returned to the scrotum, the liquid secreted from the visceral layer being absorbed by the cellular tissue with which it is now in contact.

The operation of opening the sac, everting it and suturing it behind the epididymis is not good. None of the parietal layer having been taken away, too much fluid may be secreted to be carried off by the lymphatics of the scrotum; the hydrocele returns.

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and even calcified; whilst the blood clots and becomes invaded with granulation tissue from the embracing wall: so that the haematocele comes to feel very solid and very much like a malignant growth. Indeed an open operation may be the only way of making a diagnosis. This is not a serious matter as a haematocele can only be treated by opening it, turning out the clot and removing the thick wall.

Varicocele

A varicocele is the varicose dilatation of veins in the spermatic cord. It is found in adolescents and young adults, tends to disappear in later life, and is nearly always on the left side. If it appears first in middle life it may be due to a renal tumour, in which circumstance it may occur on either side of the body. It forms a visible subcutaneous mass of dilated veins which are said to feel like a bag of worms. The scrotum is always lax and the testicle pendulous. The patient may be quite unaware that he is in any way abnormal, but in other cases there is some dragging pain in the groin or even a neuralgia testis. The patient is often much concerned about his condition. As a rule reassurance is all that is necessary. The wearing of a suspensory bandage for the testicle is often a relief. Only in extreme cases, unless it is a question of making the patient eligible for one of the Services, is it right to operate. A section of the dilated veins 1½ to 2 inches long is resected from the cord and the testicle raised by suturing the severed ends of the veins together. One or two small veins should be left to provide for return of the blood from the testicle, but even so atrophy of the organ is a very frequent result.

Injuries to the Testicle

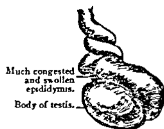
The testicle may be injured in riding, by a blow in assault or sport, or in a car accident. Such a crushing injury leads to a laceration of the testicular tissue within the tense tunica albuginea, and destruction of numbers of tubules. In extreme cases actual gangrene may take place. Such an accident is likely to cause the patient to faint from the extreme pain, and is soon followed by staining of the scrotum with blood and swelling of the testicle, which becomes exquisitely tender. It is best to make the patient lie in bed with the scrotum supported on a pillow between the legs. Moist warm compresses hasten the resolution of the swelling, but at first may not be indicated as they may cause increased pain from a more intense hyperaemia. When the tension within the testis is very great, an

incision should be made in the capsule in order to prevent pressure necrosis of undamaged tubules.

Rarely a blunt force will dislocate the testicle out of the scrotum either into the inguinal canal or into the perineum. If seen soon after this accident has taken place, reduction of the dislocation is easily effected under anaesthesia.

Torsion of the Testis

This is a condition which is seen only in the incompletely descended testis. A twist occurs either in the spermatic cord just above the testis or between the testis and the epididymis, for in these cases there often exists a long mesorchium between these two structures. The torsion is supposed to be brought about by irregular contractions of the cremaster and abdominal muscles. When the accident occurs there is sudden pain in the groin. The testis swells up, and above it in the inguinal canal, the twisted cord forms an elongated swelling. Since there is a good deal of abdominal pain and the patient vomits, whilst there is, of course, no impulse in the swelling on coughing, there is a striking similarity with a strangulated hernia. The diagnosis is made quite clear by the absence of the testis from the scrotum.



Torsion of spermatic cord.

As soon as possible an attempt should be made to undo the twist. The surgeon cannot know in which direction this has occurred, but if he attempts to twist the wrong way the pain will be increased; whilst a twist in the right direction will give relief. Such manipulation may fail. If this is so, an open operation will be required. In neglected cases the testis may be gangrenous and have to be removed.

Tumours of the Testicle

Innocent tumours of the testicle are so rare that they need not be further considered. Malignant tumours vary considerably in structure but primarily, as they grow from germinal epithelium, they would all seem to be embryomata. They may conveniently be divided into two groups: (1) seminomata which are homogenous on section and composed of masses of epithelial cells lying in a fine stroma, and (2) teratomata containing tissue from all the three primary germinal layers: epiblast, mesoblast and hypoblast. Hence there are epithelial

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because of enlargement of its vessels, but perhaps also because of increased connective tissue necessary to carry the added weight. Sometimes a secondary nodule of growth is actually palpable in the cord. The glands secondarily affected lie close to the aorta just below the renal arteries. Hence they form an abdominal tumour. Metastases are also seen in the lungs and rarely in lymphatic glands in the neck and axilla. A haematocele may so strongly resemble a malignant growth of the testicle in its physical characters that it may be impossible to distinguish between the two before operation. Ultimately the tumour becomes adherent to the scrotal skin through which it fungates, forming a foul malignant ulcer.

If the tumour contains chorionic cells the Aschheim-Zondek reaction is positive. Gynaecomastia has sometimes been seen.

In general it may be said that tumours of the testicle are very malignant. Sometimes the whole course is extremely rapid. In others a small nodule may have been present for years before suddenly the disease lights up and quickly compasses the death of the patient. The teratomata are much more malignant than the seminomata. There is some hope for a man with a seminoma but very little for one with a teratoma.

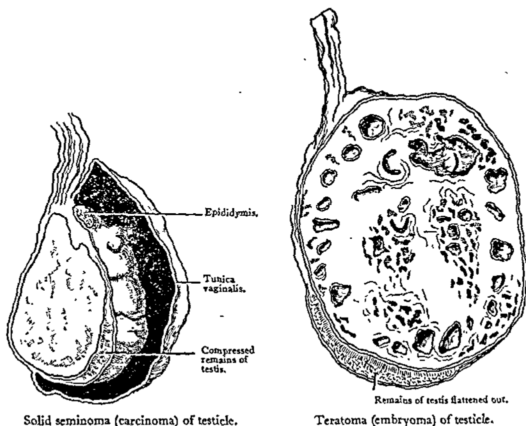
The best treatment is orchidectomy with X-ray therapy of the glandular areas in the abdomen. Years ago a trial of radical extirpation of the testicle, the cord and the aortic glands in one piece was made but the results did not warrant the operation becoming standard practice. The seminomata are much more sensitive to radiation than the teratomata, though sometimes radio-resistant examples are met with. A man may live 8, 10 or 12 years, perhaps more, after the local removal of a seminoma and the radiation of the aortic glands.

Imperfect Descent of the Testicle

The testis does not always migrate in the normal fashion from its primitive position just caudal to the kidney to its adult final position in the scrotum. Some disturbance in this process may take place which is either a failure to complete the normal process, or the transit of the testicle to some situation outside the scrotum. In the first case there is said to be incomplete descent; in the second the condition is said to be one of ectopia testis. It is very important to distinguish between these two abnormalities. When the testis is incompletely descended there is simply an arrest of a normally begun process; but this may be serious because not only is there a failure of full growth of the proper testicular tissue but the spermatic artery may be so short as to be an insuperable barrier to bringing the organ into its

and glandular elements, cartilage, bone, sarcomatous and sometimes chorionic cells. These tumours are not homogenous on section and often contain cysts or haemorrhages.

Scattered here and there in seminomata may be found a few elements derived from the other germinal layers. Hence these tumours are regarded as embryomata in which the epithelial development preponderates almost to the exclusion of all other tissues.



Solid seminoma (carcinoma) of testicle. Teratoma (embryoma) of testicle.

These tumours of the testicle occur at an earlier period of life than most malignant growths. The average age for teratomata is 28: for seminomata, 40. Tumour growth is rather frequent in imperfectly descended testicles, but in these it is not so common in the abdominally retained organs as in the ectopic testicle or those situated in the inguinal canal.

The disease begins as a painless swelling which is usually discovered by chance. Attention may be called to it by a dragging sensation. Indeed a malignant testis does seem heavy for its size when weighed in the hands. The surface of the growth which is in the body of the testicle, is smooth at first. Later it becomes bossed and softened areas appear as the growth comes through the tunica albuginea. Testicular sensation is lost very early in the disease. A haematocele, more rarely a hydrocele, may be present. The cord is often thickened

should be put off until about this age. Pregnyl and other hormones have been given and much has been claimed for them. The evidence does not withstand criticism and the treatment is objectionable; for it causes enlargement of the penis and the growth of pubic hair and has been known to cause a persistent erection of the penis, all without influencing in any way the transit of the testicle. When, at about puberty, an operation is done, the difficulty is seen to be that the spermatic vessels are too short to reach the scrotum without tension. The vas deferens is always sufficiently long; indeed it often precedes the testis with the epididymis, which is connected with the body of the testis by a long mesorchium. By carefully dissecting away all the coverings of the cord and cleaning up the spermatic vessels following them up behind the peritoneum with the finger, it is often possible so to mobilise the testis that it will comfortably reach the bottom of the scrotum. Sometimes the division of the deep epigastric artery seems to assist; but although the artery to the vas carries sufficient blood to the testis to prevent gangrene after division of the spermatic artery, this should never be done for it inevitably leads to atrophy of the organ. The body of the testicle is usually sutured to the bottom of the scrotum, and the stitch can with advantage be used to fasten the scrotum to a convenient spot on the thigh.

Some surgeons transfer the testis to the opposite side of the scrotum through a hole made in the septum, but there does not seem to be any real advantage in this.

Should it prove impossible to bring the testis down, it should be placed within the abdomen under the peritoneum of the iliac fossa unless the patient is an adult with all his secondary sex characters, when it should be removed.

Since the ectopic testis will never reach its right destination, it should always be operated upon. The surgical problem is much simpler, as the structures of the cord have grown to a sufficient length to allow the organ to lie easily in the scrotum. So the testis is put into its proper position and any hernial sac tied off.

proper place in the scrotum. On the other hand, when there is ectopia these anatomical structures may have reached full development although *the testis is in some abnormal place.*

The incompletely descended testis may remain within the abdomen or it may be in the inguinal canal, at the external ring, or a little lower. Both testes may be retained (cryptorchidism). *It is quite common for there to be only delay and for the descent to take place* at about the age of puberty. A testis which fails to reach the scrotum is usually without the power to produce spermatozoa; at most it has a short-lived faculty for spermatogenesis which occurs about the age of 21 *years. Hence cryptorchids are as a rule sterile.*

In ectopia it is supposed that there is some derangement of the mechanism by which the gubernaculum drags the testis into its proper place in the scrotum. It may be found (1) lying on the surface of the external oblique, *having come out of the inguinal ring and turned* upwards (abdominal ectopia), (2) in front of the pubes (pubic ectopia), (3) in the perineum (perineal ectopia), or (4) very rarely in Scarpa's triangle, which it has reached by passing under Poupart's ligament through the crural canal (crural ectopia).

It is very common for a hernia to accompany an undescended testicle. Even when there is no hernia present there is usually seen at operation a tiny sac communicating with the abdomen by a small aperture. An accompanying hernia may be of the interstitial variety. *A testis retained in the inguinal ring is liable to attacks of traumatic orchitis which are perhaps due to contractions of the abdominal* muscles. Torsion of the testicle occurs only when the organ is incompletely descended, and malignant disease is more common than when it is in its normal situation.

The diagnosis of the condition is very easy. Not only *is the testicle absent from the scrotum but this latter structure is poorly* developed. *A* mistake is sometimes made because *in some young* children the cremaster is so active that its contraction will push the testis up into the inguinal canal. In such circumstances, however, the organ can always be milked down again into the scrotum. In ectopia the testis is easily felt in its abnormal position. A testis *which is easily palpable in the inguinal region is an ectopic abdominal* organ; *if it lies in the canal it is usually not possible to feel it.*

If both organs are retained within the abdomen *there is nothing* to be done. If an incompletely descended testis is in the inguinal canal or lower there is no hurry to take any steps unless there is a hernia which is giving trouble, an attack of orchitis or a torsion of the cord. *The vast majority* of incompletely descended testes pass into the scrotum at *or just* before puberty. Therefore any operation

should be put off until about this age. Pregnyl and other hormones have been given and much has been claimed for them. The evidence does not withstand criticism and the treatment is objectionable; for it causes enlargement of the penis and the growth of pubic hair and has been known to cause a persistent erection of the penis, all without influencing in any way the transit of the testicle. When, at about puberty, an operation is done, the difficulty is seen to be that the spermatic vessels are too short to reach the scrotum without tension. The vas deferens is always sufficiently long; indeed it often precedes the testis with the epididymis, which is connected with the body of the testis by a long mesorchium. By carefully dissecting away all the coverings of the cord and cleaning up the spermatic vessels following them up behind the peritoneum with the finger, it is often possible so to mobilise the testis that it will comfortably reach the bottom of the scrotum. Sometimes the division of the deep epigastric artery seems to assist; but although the artery to the vas carries sufficient blood to the testis to prevent gangrene after division of the spermatic artery, this should never be done for it inevitably leads to atrophy of the organ. The body of the testicle is usually sutured to the bottom of the scrotum, and the stitch can with advantage be used to fasten the scrotum to a convenient spot on the thigh.

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CHAPTER LI

DISEASES OF THE URETHRA

Gonorrhoea

Gonorrhoea is almost invariably acquired during sexual intercourse. The usual incubation is 3 to 5 days. There is at first felt an irritation at the meatus followed by an uncomfortable sensation and then pain during micturition. A discharge appears which soon becomes purulent and profuse. At the height of the inflammation, which occurs at about the end of the first week, there may be some fever and considerable pain. The meatus is red and pouting. The whole glans is swollen and inflamed. The prepuce is oedematous; there may be a bad balanoposthitis. The penis is enlarged from inflammatory infiltration of the corpus spongiosum; this prevents its normal distension, so that if an erection occurs, which it commonly does at night, the organ becomes curved (chordee), a condition which is very painful. At the height of the disease there is frequent painful micturition, and the discharge is greenish in colour or blood-stained. The strangury is due to the inflammation having spread to the posterior urethra, but this does not invariably happen. If it does, the pathway is open for the inflammation to spread to the prostate, the seminal vesicles, and along the vas deferens, to the epididymis. A pure gonococcal infection is not likely to set up a cystitis, but if there is a secondary infection with pyogenic organisms this complication is common. Sometimes swelling leads to acute retention of urine. The acute prostatitis occasionally goes on to abscess formation. A more common complication is an infection of one of the glands of Littré and the formation of a peri-urethral abscess. Cowper's gland when inflamed forms a tender lump just behind the scrotum in the perineum; it may suppurate.

The acute stage lasts from 7 to 10 days, when a gradual subsidence occurs. The whole disease lasts 6 to 10 weeks. After this time the infection, if it persists, is spoken of as a chronic gonorrhoea. This is characterised by a scanty discharge called a gleet, noticed chiefly in the morning; and by the presence of threads in the urine. Threads

coming from the anterior urethra are long spiral structures composed of mucus, in which are entangled leucocytes, and desquamated epithelial cells; those from the prostate are short stumpy comma-like bodies. The chronic infection is kept up by residual disease in a urethral gland, in the seminal vesicles or in the prostate.

From the posterior urethra the organisms may enter the blood-stream and so lead to other inflammations: arthritis, tenosynovitis, pericarditis, endocarditis, pleurisy, peritonitis or iritis. The microbes may be conveyed by the fingers to the conjunctiva.

The treatment of acute gonorrhoea has been revolutionised with the discovery of penicillin, with which drug a complete and rapid cure can be obtained. Indeed a single dose of 150,000 units in a slow release medium (cera flavum 3 ol. arachis 97) suffices. Or 30,000 units can be injected every two hours for 5 doses. No other treatment is usually needed. Occasionally when the discharge persists for a little it is advisable to employ irrigation of the anterior urethra at a pressure of 2 or 3 feet with 1 in 10,000 potassium permanganate. But as a rule this is quite unnecessary.

Before the penicillin era, very good results were obtained by courses of sulphadiazine, but the cure took longer. In order to know when cure is complete, a test should be made after the delay of a month. The patient either has a good dinner one evening with a fair quantity of wine and liqueurs, and comes up for a test the next morning not having passed urine after 2 A.M., or he is given a provocative injection of 300 million gonococci. Any discharge which can be obtained by massage of the prostate or the seminal vesicles, or any threads in the urine, are examined microscopically for gonococci.

Should during the course of the disease there be evidence of an acute prostatitis, a fulness and burning in the rectum, accompanied by much strangury with the expression of a few drops of blood at the end of micturition, local irrigations, if being used, should be stopped. Acute retention of urine, if it is not caused by the pressure of a peri-urethral abscess, is due to acute prostatitis. It may give way to a hot bath and an injection of morphin. When it does not, a rubber catheter is passed after irrigating the anterior urethra with potassium permanganate. A prostatic abscess may require opening (page 723). A peri-urethral abscess forms a round, very tender tumour on the floor of the urethra. If it does not discharge itself into the lumen of the urethra, it should be opened from without and the wound packed. A Cowper's abscess will require the same treatment.

Acute conjunctivitis is a very serious complication indeed because it is apt to spread to the cornea, causing ulceration, and perhaps even

panophthalmitis with the loss of the eyeball in the end. As there is a very great likelihood of the inflammation being conveyed to the opposite side, the other eye should be shut off with a Buller's shield. The affected eye should have frequent irrigations with boric lotion and, after cocainisation, penicillin drops instilled. If there is any evidence of the cornea becoming affected, 1 per cent atropin should also be instilled. The warts which are sometimes found on the glans in gonorrhoea are best destroyed with the diathermy cautery.

When there is chronic gonorrhoea, the focus of infection in the prostate, vesicles or gland of Littré must be eradicated. Local treatment consists in massage from the rectum, of the prostate or vesicles twice a week, or the destruction of a chronically inflamed gland of Littré through a urethroscope, with solid silver nitrate fused on a probe, or the actual cautery. Penicillin and sulphadiazine are very effective in these chronic cases. Vaccines may be given at the same time.

Gonorrhoea in Women

Gonorrhoea in women is a much milder complaint than in men and sometimes passes unnoticed. In the main the inflammation affects the urethra and the cervix uteri. The symptoms are quite mild. There is a discharge, and a little irritation on micturition. Penicillin should be administered as recommended for men. Vaginal irrigations of 1 in 10,000 potassium permanganate, followed by a glycerin tampon or pessary, should be given daily or twice a day. Sometimes an acute abscess forms in Bartholin's gland which will need opening. Proctitis is apt to arise from the discharge running backwards into the rectum. It is mild and easily cured by permanganate irrigations. Gonorrhoeal warts are commoner than in men. They may form a great mass around the vulva.

Gonorrhoea is more likely to become chronic than in men. The infection settles down in the glands of the cervix or in the urethra and is very difficult to eradicate. If Skene's tubules, close to the opening of the urethra, are affected, they are best destroyed with the electric cautery. Sometimes the focus of infection is in Bartholin's gland which can be excised. Chronic cervicitis or endometritis is treated by the intra-uterine injection of 2 c.c. of glycerin. Penicillin, sulphadiazine and vaccines appear to be as effective in the chronic gonorrhoea of women as of men.

At any stage of the disease the infection may spread up to the Fallopian tubes and reach the peritoneum (page 477).

The test for cure is made by searching the secretions of the urethra and cervix after a provocative injection of gonococcal vaccine.

Gonorrhoea in Female Children

Little girls are very susceptible to infection with the gonococcus. They acquire it from an adult woman custodian. If such a sufferer gains admission to a hospital ward the infection is extremely likely to spread to other children; so great is the danger, that, in most hospitals, every child on admission has a smear taken from the vulva, which is tested for gonococci. In children the disease is usually a vulvovaginitis; it does not affect the urethra or the cervix. Penicillin treatment quickly cures children. No local measures are needed.

Fibrous Stricture of the Urethra

Fibrous stricture of the urethra is due either to inflammation or to an injury. By far the larger number of inflammatory strictures follow a gonococcal infection; much less rarely they are the result of syphilis, tuberculosis or pyogenic organisms. The syphilitic stricture occurs at the site of an intra-urethral chancre and so is situated in the fossa navicularis: tuberculous strictures nearly always are situated in the prostatic urethra and are associated with a tuberculous prostatitis; only exceptionally are they found in the anterior urethra: strictures due to a pyogenic infection are found only at the meatus, and follow a severe balanoposthitis. Gonorrhoea does not lead to a stricture in women; in them strictures are the result of tuberculosis, syphilis or an injury done at childbirth. In men traumatic strictures occur in the bulb from a fall on the perineum, or in the membranous urethra associated with a fracture of the pelvis.

Gonorrhoeal Strictures

Gonorrhoeal strictures of the urethra, 80 per cent of all strictures, occur 2 or 3 years after the infection, never earlier. The commonest site is in the bulb, just in front of the triangular ligament; it is said because, in the erect posture, owing to the curves of the urethra, this is where the secretions of the anterior urethra trickle by gravity and collect. Hence a greater intensity of inflammation in this situation. At the site of a stricture there is no ulceration but a submucous infiltration around an infected urethral gland. This ultimately leads to a considerable area of fibrosis in the neighbourhood, and to subsequent contraction, with an encroachment on the lumen of the urethra. Strictures are designated annular or tubular, or, if the fibrosis surrounds only a portion of the circumference of the urethra, bridle strictures. They are very often multiple, but always in the anterior urethra.

ere are dilatation of the urethra behind the stricture, and invariably)osterior urethritis. In long-standing cases the bladder, ureters l the kidney pelves may share in the dilatation and lead to the death the patient by uraemia, partly due to the interstitial fibrosis which 'ays accompanies such back pressure, and partly because the infec-ı in the posterior urethra spreads up, and gives rise to a septic :lonephritis. Acute retention of urine may come on at any time m an inflammatory swelling which closes the narrow opening of urethra; and ulceration behind, combined with sepsis, may lead penetration of the wall of the urethra, with extravasation of urine.

The most important symptom of stricture is difficulty in micturi-ı. The stream is narrow and feeble; expulsion has to be aided contraction of the abdominal muscles. After the supposed com-tion of the act there is dribbling from the external meatus due to slow escape of the urine which has collected behind the stricture :he dilated posterior urethra distal to the shut internal sphincter. : bladder may dilate to the degree that its lumen cannot be obliter-l on contraction, thus there is left residual urine in it after the of micturition. Finally there may occur overflow incontinence, ıeen in some prostatics. As time goes on the difficulty with mic-tion becomes progressively worse, until one day absolute retention urs. This complication is likely to be precipitated by the con-ıption of alcohol, exposure to cold, or the forced holding-up of water in the bladder. The urine is always cloudy with pus, and tains threads.

The diagnosis is suggested by the history. Sometimes it can be firmed by feeling a hard mass in the corpus spongiosum, usually he region of the bulb. It is really made by exploration of the :hra with an acorn-headed bougie. A No. 20 F. instrument of nature is passed down to the obstruction. It may be too big to ; through the stricture; if so, a smaller one which will pass, is l. The surgeon feels the resistance of the stricture as it goes the bladder; and, as it is withdrawn, it again gives the sensation n obstruction. The length of the stricture can be gauged by this œuvre. Sometimes nothing but a filiform bougie can be made)ass, and then perhaps only with difficulty is the entry to the ture found, since it so often lies excentrically; bending the last inch of the bougie at an angle and slowly rotating it at the face he stricture will assist in the search. A spasm of the muscle ounding the wall of the urethra, or a fold of the mucosa, may hold fine instrument and lead to error. This is where the acorn-tipped gie is so useful; for, on withdrawal, it will be felt to jump over a ture; it will come out smoothly if it has only been hindered by

spasm or a mucosal fold. Obstruction due to an enlarged prostate can usually be recognised by rectal palpation. With a stricture the point of the instrument against the obstruction can be felt in the perineum; with prostatic obstruction the instrument will be felt to have penetrated more deeply into the canal. It is most unusual to find an enlarged prostate in association with a gonorrhoeal stricture, for the latter occurs only when there has been a posterior urethritis of long duration, and a chronic prostatitis which leads to fibrous contraction of the gland.

The treatment of stricture is carried out preferably by the method of intermittent dilatation. Gum elastic bougies are passed until one is found that is just held by the stricture. It is left in position for a few minutes, then removed, and the patient sent home. It is a fortunate fact that, if there are multiple strictures, the calibre of the deepest stricture is always the smallest, so that all the strictures are treated by the same instrumentation. During the next few days the patient notices that there is an increase of his gleet; a mild mechanical inflammatory reaction has taken place at the site of the stricture; it leads to some resolution of the scar tissue. At the end of a week the patient returns, when it will be found that not only can the originally gripped sound be passed, but sounds two French sizes larger. The dilatation is carried on gradually in this way, metal bougies being substituted for the gum elastic instruments when the size 18 F. has been reached; because metal sounds give a better reaction. When full dilatation has been arrived at (26-30 F.), the patient comes at gradually increasing intervals until, finally, he pays a visit for dilatation only once a year.

When only a filiform bougie can be made to pass, and that with difficulty, it is best to tie it in the urethra; 24 hours later it can be withdrawn and a slightly larger one inserted. As soon as possible this continuous dilatation should be abandoned for the intermittent method.

Urethrotomy is the term given to the division of a stricture with the knife, either from within the canal (internal urethrotomy) or from without (external urethrotomy).

Internal urethrotomy is indicated when the fibrosis around a stricture is so massive or dense that no progress is made by intermittent dilatation; or when the stricture quickly closes down again after it has been dilated (resilient stricture); or when for some reason there is not the time available for the intermittent procedure. It can only be carried out when a filiform guide can be passed through the stricture to which the cutting instrument, usually Maisonneuve's urethrotome, can be attached. This carries a little knife by which the roof of the urethra in the region of the stricture is divided.

External urethrotomy, usually Wheelhouse's operation, is indicated under the same circumstances as the internal procedure if the urine is infected; it is also required when there is extravasation of urine, a peri-urethral abscess is present, or a stricture is impassable to any instrument. It consists in dividing the stricture from an incision in the middle line of the perineum.

Retention of Urine

If this complication occurs relief is very occasionally afforded by the patient sitting in a hot bath in which he passes his water. Usually, however, it is necessary to catheterise him. The anterior urethra should first be filled with 5 per cent novocaine-adrenalin solution; this will diminish the hyperaemia of the mucous membrane and cause the swelling to subside, and also abolish muscular spasm. A No. 10 F. olive-pointed catheter is then passed, or one smaller, or perhaps only a filiform bougie. If nothing but this latter instrument will penetrate the stricture, relief will be afforded if it is left in place; at first the urine will trickle out beside the instrument drop by drop, later in a more considerable stream. Such a bougie should be tied in for 24 hours when almost certainly a larger instrument can be introduced.

If no instrument at all can be made to pass the stricture, the patient's anguish is relieved by aspirating the bladder through its extraperitoneal area above the pubes by means of a fine-bore trocar and cannula. Within 24 hours catheterisation will usually be possible; if it is not, an external urethrotomy is necessary.

Extravasation of Urine

This is one of the most serious complications that can occur in stricture. It happens as an acute or a chronic phenomenon. The former is due to a great augmentation of the virulence of microbes growing in the mucosa of the urethra behind the stricture, coupled with the breaking-down of the resistance of the tissues. A spreading inflammation takes place in the substance of the corpus spongiosum, with necrosis and digestion, which forms a cavity to which the septic urine has access. Once this occurs the organisms appear to be endowed with renewed destructive activity; the inflammation spreads with great rapidity.

The illness begins with a sudden pain and swelling in the region of the bulb. There are high fever and malaise. In a few hours the area of inflammation has spread to the scrotum, penis and anterior abdominal wall as the urine infiltrates these regions. The infiltration

is prevented from passing backwards into the perineum by the attachment of Colles' fascia to the posterior border of the triangular ligament; and from passing down the thighs by the attachment of Scarpa's fascia to the deep fascia of the thigh. Frequently there is retention of urine, and any attempt by the patient to empty his bladder causes great pain, and increases the extravasation. The patient quickly becomes very ill with rapid pulse, shallow breathing, furred tongue and delirium. He may very speedily die from toxaemia, or, if he survives a day or two, to general septic infection and pyaemia.

Extravasation brooks of no delay in treatment; even a few hours may mean the death of the patient. Immediately, under an anaesthetic, incisions should be made wherever the inflammation has spread: the perineum, the scrotum, the penis and the anterior abdominal wall. The perineal incision may open into the urethra. No more should be done for the time, as the multiple incisions will give exit to the urine and pus in the tissues; but if the inflammation has not reached the hypogastric region, a suprapubic cystotomy is an additional precaution, and should be done. A great deal of sloughing of the wounds always occurs which can be treated by the use of hydrogen peroxide, and sitting the patient in a bath twice a day. Only when the wounds are cleaning-up should the stricture be treated, for which an external urethrotomy is necessary.

In chronic extravasation of urine the process is very slow; a hard mass gradually forms in the substance of the bulb and spreads to the subcutaneous tissue. Sooner or later an abscess occurs which, opening on the surface, gives rise to a urinary fistula. The inflammation may spread widely and cause many sinuses to form. In the treatment it is necessary to make incisions in all the indurated areas and to perform an external urethrotomy.

Traumatic Stricture of the Urethra

Traumatic strictures, unlike gonorrhoeal strictures, come into being within a few weeks of the causative lesion. They may be in the membraneous urethra as well as anterior to the triangular ligament. They are treated by intermittent dilatation but they are sometimes very rebellious. (See injuries of the urethra below.)

Congenital Stricture of the Urethra

A congenital stricture occurs most commonly at the meatus, and may be so narrow that there is dilatation of the urethra behind it, of the bladder, and in extreme cases, of the ureters and kidneys. The

abnormality is easily corrected by a median incision of the floor of the urethra in the middle line, and suturing the mucous membrane of the urethra to the covering of the glans.

A much rarer congenital narrowing is due to an abnormally large size of the two folds which run laterally and backwards from the verumontanum. These folds, by the pressure of the urine behind them, may be converted into semilunar valves, which offer more obstruction to the urine coming out of the bladder than to the passage of an instrument into this cavity. Dilatation of the urinary tract behind may follow as in the other variety. Curiously enough, symptoms are sometimes not observed in childhood but only in adult life; they are the same as those due to other strictures of the urethra. The folds can be seen through the posterior urethroscope. Very few cases have been recorded; sometimes dilatation has been successful, in others division of the folds either through the urethroscope or after opening the bladder has brought relief.

Diverticula of the Urethra

Diverticula of the urethra are found usually in the floor of the anterior urethra. They are often congenital in origin but they can be acquired from a weakening of the floor of the urethra from inflammatory disease. These saccules fill up during micturition, and lead to dribbling after the act. Stagnation of the urine in the diverticulum may be the cause of stone formation and lead to infection of the urinary tract. Therefore they should be removed; it is easily done.

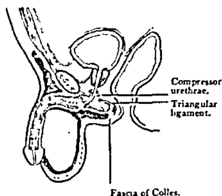
Injuries of the Urethra

Injuries from Without

Injury to the urethra in front of the triangular ligament is due to a blow on the perineum or to falls astride some hard object. There may be simply a bruising of the urethra, or the canal may be torn partly or completely across. There is great pain and very soon a swelling appears in the perineum which is a haematoma. Bruising is visible in the neighbourhood. Blood trickles out of the urethra apart from micturition. Should the individual attempt to pass his urine there is an increase of the swelling accompanied by more severe pain. Very often there is a protective spasm of the compressor urethrae which leads to retention of urine, dilatation of the bladder and the characteristic cramps.

If the patient can pass his urine, and this act is not accompanied

by an increased swelling in the perineum, there is only a contusion of the urethra and the surgeon can wait, being on the look-out for extravasation of urine. Should the swelling increase with micturition, there is a partial rupture of the urethra; a suprapubic opening in the bladder should be made, and an incision in the infiltrated area down to the site of the injury.



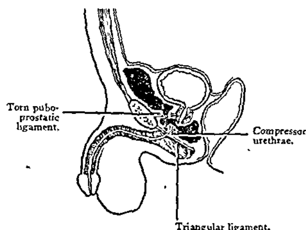
Rupture of urethra in front of triangular ligament, showing paths of extravasation of urine.

Should the patient be unable to pass his urine, a more serious injury than a contusion is probably present; a rubber catheter should be passed. If it goes into the bladder there is a partial rupture of the urethra only. A suprapubic opening must be made; if there has been no extravasation no further steps need be taken. If the catheter cannot be made to enter the bladder there is a complete rupture of the urethra. After making a suprapubic bladder opening the torn urethra in the perineum should be exposed, and the roof of the urethra be restored by sutures. An instrument should be passed on the 12th day. In treating ruptures of the anterior urethra an in-dwelling catheter should never be used as it sets up sepsis, and leads to the formation of stricture.

Rupture of the urethra behind the triangular ligament is the result of a fracture of the pelvis. There is very great shock, and only a little blood may escape from the meatus. The rupture takes place at the apex of the prostate, and as the pubo-prostatic ligaments are also torn, the prostate and the posterior urethra fall backwards: so that the two ends of the urethra are no longer in apposition. A large haematoma forms in the pelvis which can sometimes be felt as a boggy mass from the rectum. No catheter will pass, and urine, if it extravasates, is confined to the pelvis, spreading up gradually on to the abdominal wall above the pubes. The most inveterate forms of stricture are liable to follow this serious injury.

At the first suspicion of rupture of the posterior urethra an operation should be done to forestall sepsis which will almost certainly lead to osteomyelitis of the pubic bone. The bladder is opened, and a catheter passed through the internal meatus until it emerges from the torn urethra at the apex of the prostate. Another catheter is then passed through the external meatus; its end will likewise appear in the depth of the pelvis. By tying the ends of the two catheters together, the second one can be pulled into the bladder where it is allowed to remain. An attempt should then be made to suture the

membranous urethra: a very difficult procedure owing to the depth at which the work must be done, and the presence of much clot and damaged tissue. A large drainage tube is then placed in the bladder and another to drain the cellular spaces in the pelvis. There will always result a stricture, but this must be treated by systematic intermittent dilatation.



Rupture of deep urethra at apex of prostate, showing area infiltrated with urine.

Injuries from Within

Injury to the urethra from within takes place as the result of the unskilful use of a catheter. The point of the instrument catches in the mucosa at the face of a stricture, or the bulge of an enlarged prostate, penetrates it and tears up the submucosal tissue, forming what is called a false passage. Such a tunnel usually ends blindly, but sometimes the instrument is forced onwards so that it enters the urethra again, or, if it has penetrated the prostate, reaches the bladder. Curiously enough there is not very much pain when a false passage is made, but the surgeon has the sensation of the catheter tearing up the tissues, and its withdrawal is followed by a considerable haemorrhage. When a false passage has been made, the rule should be that no urethral instrumentation should take place for 6 or 7 days. If there is retention of urine, this can be relieved by a suprapubic puncture. Blind false passages heal up quite well as the urine has no tendency to enter them, but a complete false passage is very likely indeed to be followed by sepsis and the extravasation of urine.

Epispadias

Epispadias is a rare deformity in which the roof of the urethra fails to develop and the canal is represented by a groove running along the dorsum of the penis. In the worst cases there is a failure of the pubic bones to unite in the middle line, and there may coexist an exstrophy of the bladder. A complicated plastic operation is required to convert the groove into a tunnel, and the patient is likely to be incontinent, unless the bladder is opened above the pubes, and the two ends of the sphincter sutured together from within, after displaying them by dissection.

Hypospadias

Hypospadias is a commoner defect in which the corpus spongiosum has not folded round the urethra as far forwards as the glans penis. The opening of the urethra may be just behind the glans, in the penile portion, or behind the scrotum in the perineum. The corpus spongiosum being poorly developed, the penis may be curved downwards, and adherent on its under surface. In the treatment the penis must be freed first, and the plastic operation on the urethra carried out afterwards. The wounds often break down from infection. The urine should always be side-tracked by a suprapubic cystotomy to assist healing.

CHAPTER LII

DISEASES OF THE PENIS

Phimosis

This is the name given to the condition in which the prepuce has such a small aperture that retraction of the foreskin is not possible. Many children are born like this but as they increase in size the orifice of the prepuce also enlarges. In extreme phimosis the opening may be no bigger than a pin-point, not even big enough to allow the urine to escape as quickly as it leaves the bladder; with the result that at each act of micturition the preputial sac swells out with urine like a balloon. This sets up such a resistance that it may actually lead to dilatation successively of the urethra, bladder and kidney pelvis behind it. In less severe degrees of phimosis inability to retract the foreskin for cleaning purposes may lead to inflammation of the preputial sac and glans penis (balanitis); and long-continued irritation beneath a tight foreskin undoubtedly predisposes to carcinoma late in life.

There is no need to circumcise a new-born baby with phimosis if the urine can be passed normally. As the child grows, attempts should be made gently to withdraw the foreskin. They will be successful. At first the inner side of the prepuce will be found to be adherent to the glans; these adhesions naturally disappear by themselves. Sometimes a long prepuce is thought to lead to enuresis; in this case, or if the aperture is very small, or if an individual over puberty is met with whose foreskin cannot be retracted, then circumcision should be performed. However this is done, a margin of mucosa should be left to protect the sensitive corona. It is claimed that a simple incision along the dorsum of the foreskin will not only relieve phimosis but will give an end-result indistinguishable from a formally performed operation.

Paraphimosis

This is a condition in which a tight foreskin is retracted behind the glans and resists all efforts of the patient to pull it forwards again.

The tightness of the aperture margin causes stasis of blood and lymph in the glans which swells up. The prepuce forms an oedematous collar around the corona; behind it there is a deep groove in which, on the dorsum, gangrene finally occurs with release of the obstruction, but at the same time the formation of a nasty ulcer. The glans itself never becomes gangrenous. The diagnosis is very evident. Under anaesthesia, by taking the penis between the first two fingers of each hand and pressing the glans backwards with the thumbs the foreskin can often be pulled forward. If this manipulation is not successful, an incision must be made through the constriction ring on the dorsum when reposition can easily be made. Either at the time, or later if there is sepsis, a circumcision should be done.

Congenital Shortness of the Frenum

A child may be born with a frenum so short that it prevents the foreskin being fully withdrawn and the penis becoming straight when it is erect. It is a simple matter to remedy this by a transverse incision of the frenum.

Injuries of the Penis

Open wounds of the penis lead to severe haemorrhage from the cavernous spaces. Bleeding must be stopped and this is usually done with sutures. Closure of the wound should be done only exceptionally, because any sepsis in the large clotted blood spaces is very likely to give rise to pyaemia. Subsequent scarring may interfere with the proper erection of the organ.

Blunt force is more likely to cause a tearing of the cavernous tissue if the organ be erect. This so-called fracture of the penis causes an immediate collapse of the organ, and a large subcutaneous haematoma, which may be so big that it leads to retention of urine from pressure on the urethra. In a serious injury of this kind it is best to operate, turn out the clot, stop the haemorrhage and suture the tear. Again, there may be serious interference by scarring.

With both varieties there may be an accompanying injury to the urethra which requires its own special treatment.

A rare injury occurs in which the penis is torn across just behind the glans which the body of the penis leaves, to take up a position under the skin of the abdomen or perineum (luxation of the penis). Reposition must be quickly effected and an operation performed to prevent the otherwise inevitable extravasation of urine.

Balanitis and Balanoposthitis

Balanitis is inflammation of the glans penis, balanoposthitis is inflammation of the preputial sac. Both are predisposed to by phimosis when the foreskin cannot be retracted for cleaning purposes. Decomposition of the smegma takes place. Balanoposthitis is very likely to occur when there is incontinence or the patient is a diabetic.

There are a burning feeling in the glans and tenderness particularly at the corona, some oedema of the foreskin, and a discharge from the preputial orifice. The condition usually quickly subsides if the glans be washed and powdered with equal parts of talc and bismuth subcarbonate. If the prepuce cannot be withdrawn, cleaning can be done only by syringing; a 1 in 10,000 solution of oxycyanate of mercury is good. In rare cases the inflammation becomes serious; the glans ulcerates, the prepuce becomes indurated, abscesses form in it and break down on the surface, the orifice becomes very much narrowed so that the decomposing secretions are retained within the sac; actually gangrene sometimes occurs. The inguinal glands are enlarged and tender, and may suppurate. The prepuce must be slit up along the dorsum and hot fomentations applied.

Erysipelas

In some of the severe fevers such as typhoid, erysipelas of the penis and scrotum may occur and give rise to extensive gangrene of the skin of the penis.

Fibroma of the Penis

A fibroma of the sheath of the corpus cavernosum or corpus spongiosum is sometimes seen. It is not the result of any inflammatory condition but is analogous with Dupuytren's contracture of the palmar fascia. A rounded nodule is found, more often on the dorsum of the organ. It is quite painless but is of importance because the fibrosis extends into the cavernous tissue and so interferes with proper erection of the penis. There is no effective medical treatment of the condition though the effect of potassium iodide should be tried. The nodule can be removed by operation, but the resulting scar may still prevent proper erection.

Tumours of the Penis

The only common tumour of the penis is carcinoma. This occurs either as a malignant ulcer or as a cauliflower-like growth. It is often

preceded by a leukoplakia of the glans penis, and is seen more often when there is some degree of phimosis. The glands affected are those in the groins. As the disease progresses an enormous foul ulcer is formed which may spread to the abdominal wall. The growth may cause interference with the passage of urine. Death occurs in 2 to 4 years from the exhaustion of septic absorption or an infection of the urine.

The diagnosis is usually simple. If an elderly patient has a balanoposthitis and a lump is felt under the foreskin, carcinoma should always be suspected; and indeed if no tumour is felt and the urine is free from sugar. In doubtful cases an incision along the dorsum of the foreskin should be made to make certain. Many times a primary chancre or a gumma has been mistaken for a growth.

Treatment consists in amputation through the body of the penis well behind the growth, when this is possible, and the removal of the lymphatic glands in both groins, even though it is uncertain that they contain metastases.

When the growth is far advanced complete amputation of the penis is recommended. In this the penis and urethra including both corpora cavernosa are removed down to the bulb. The urethra is made to open on to the surface of the perineum. Both inguinal lymphatic regions are cleared out. Sometimes both testicles are removed, but other times the scrotum is split in the middle and these organs preserved.

APPENDIX

Amputations

Whilst the discussion of amputations belongs, more particularly, to the domain of operative surgery, there are certain facts about these operations which the practitioner should know.

In general, the only indications for amputation are malignant disease in the limb, and gangrene, however it may arise. Rarely, in the leg, prolonged sepsis, such as follows osteomyelitis, may threaten a patient's life from amyloid disease, or acute sepsis endanger it by direct toxaemia; or two tuberculous joints in one leg may render it quite useless for locomotion, and be a source of constant ill health. All these circumstances may justify an amputation. It should always be remembered that it is a far more serious step to amputate an arm or hand than a leg or foot.

Amputations of the Upper Limb

Below the elbow the instrument maker prefers a stump 7 in. in length. No surgeon should truckle to such demands. Many patients prefer not to wear an artificial limb with all its straps and cramping appurtenances around the thorax. In such cases it is important to leave every inch of limb possible. An artificial arm is not so extraordinarily useful as at first sight it might appear to be. For instance it is quite impossible to rotate the forearm with an artificial limb.

Above the elbow the instrument maker prefers a stump 8 in. long, but the same remarks about artificial limbs apply here.

The consideration of the position of the scar, the length of flaps, the treatment of the nerves and the stump after operation are all considerations for the operative surgeon.

Amputations of the Lower Limb

When an amputation of the leg has been decided upon certain considerations come to the fore. They concern the fitting of an artificial limb.

Above the knee the ideal length of stump for the instrument maker is 10 in.–12 in. If the stump be too short shoulder control becomes necessary and the weight is taken on by the tuber ischii. This renders the apparatus more cumbersome.

Below the knee the ideal length is $5\frac{1}{2}$ in.

Syme's amputation is a disarticulation at the ankle joint with the removal of both malleoli and a thin layer of cartilage and bone from the lower end of the tibia. The stump is covered by a heel flap. This amputation is viewed with

disfavour by a number of surgeons, who, in place of it, amputate at the site of election $5\frac{1}{2}$ in. below the knee. This should never be done. A patient with a Syme amputation can walk about his bedroom, proceed to the bath and so on without any apparatus. Many such amputations are a success. In those in which the heel flap is not equal to the pressure of walking a secondary amputation can always be done. This procedure is strongly recommended.

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